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B. BURGESS, CAPTAIN,
Secretary.

WHITEHALL YARD,
November 1, 1884.

Sir GEORGE ELLIOT, in reply, said :[1] I shall commence my reply to the remarks which have been made by expressing my gratification at the amount of support my opinions have obtained from Captains Fremantle, Long, and Noel, and I will now endeavour as shortly as possible to refer to the objections which have been raised. Captain Noel has questioned the sufficiency of height which the submerged armoured deck would afford for engine-room and boilers. It was only yesterday I sat down to make an attack against my own paper, and that was one of the remarks I put down; but if you look to the numerical order of qualifications I have shown in my table, you will see that light draught is the last element to be considered in a line-of-battle ship, and therefore I should propose that they be built as deep down as our harbours and docks will allow. I believe that our largest ships are already drawing 28 feet of water, and I therefore think Captain Noel will find it is not impossible to put engines underneath that armour-plated deck. Many points upon which the discussion has turned have been, I think, wide of the mark: that is to say, that they do not affect the leading features of my paper. I had two objects in view: one, the fleet action; the other, the single action; and I think the requirements of those two cases are very different. Almost all Captain Colomb's remarks were with regard to the single action, and there, with the exception of the bow-to-bow attack, I don't think he differs widely from me in opinion on general principles. I say speed is essential, so does he; and as to gun-power, I agree with him and also with Captain Long. In fact, in no part of my paper do I disagree except where I said that speed and gun-power are less essential in fleet actions than in single actions, whilst handiness will prove a far more prominent feature of success, and I therefore strongly advocate two classes of fleet ship. If I sacrifice any portion of speed and gun-power, I consider that I gain more than an equivalent of fighting power in fleet actions by obtaining a handier ship. Then with regard to the bow attack in single actions, Captain Colomb agrees that ship *y* could only avoid the ram encounter by fighting stern on, and he accepts my ultimatum; but when he asks me to show why the bow is less vulnerable than the stern in a running fight, I need only point to *x*'s protected bow as described in my paper, and to *y*'s unprotected stern and steering gear only protected by penetrable armour, and to the exposed screw propeller. Captain Colomb estimates that in a stern fight ship *y* would have the best of it, notwithstanding *x*'s fortified bow, and he appears to rely chiefly on the effect of his stern torpedo fire; on this point I join issue with Captain Colomb. I do not ignore the advantage of stern torpedo fire in a ship advancing end on, but it would be liable to great inaccuracy, and I place reliance on the invulnerability of a bow with under-water protection, such as I have described in my paper. Captain Colomb says: "You cannot make your enemy meet you bow to bow;" I never said you could do so, but I said, if he does not meet you bow to bow he must eventually turn his quarter to you, and in that way I say he places himself at a disadvantage, with his stern opposed to my well-protected bow. Captain Colomb says, that at three or four miles off he would turn his broadside to *x*, and what of that? *x* advancing end on would certainly present a smaller object to *y* than *y* does to *x*, but *y* could only remain in that position for a few minutes, as he must turn away and fight stern on.

Admiral BOYS: Is not his broadside more powerful?

Sir GEORGE ELLIOT: He has his two turrets and he is firing against my bow, but if my bow is armour-plated I have a much better chance with my one or two guns than he has with his four, because his shot would glance off and would not do much damage. I think we are all for speed, but you cannot get speed without sacrificing handiness. I will defy you to do so. Speed means greater weight of engines and coal, finer lines, a longer ship, and the consequence is you do not get so handy a ship. In fleet actions it is totally different. In single actions your speed will tell, but when you get into a *mêlée* I do not think your speed will enable you to turn round so quickly as if you had got a short, handy ship. Now as regards the spur. I go back to my sailor days. What did you put a gripe on your boat for? Why to keep the boat to windward: and so it is with the spurs. If you put a spur on

[1] Sir G. Elliot's reply escaped attention when the paper was sent to press.—ED.

to that ship you will find there is a large area of lateral resistance keeping that ship from turning. Then comes the question of stem to stem. I never meant literally bow to bow or stem to stem; that is not the object I would seek for, but it is only what I would be driven into if I could not get what I wanted, which is, my stem into his bow. If I can bring my stem to strike him on the bow I get an immense advantage. I say if one ship has a stronger bow than the other, and if I can get the least advantage of direction of stem, that the consequences will be fatal to the weaker bowed ship, and that is what handiness will give me. I recollect an old Officer at Portsmouth, when the "Thunderer" was lying with her bow on to the "Inflexible," bow to bow; I said, "If these two ships were to run into each other at 10 knots, what would happen? "Well," he said, "I do not think I should bring up until I got to her central citadel"—he referred to the "Thunderer" having her armour-plating right forward, as against the comparatively weak bow of the "Inflexible." I never intended stem to stem. I say the shorter, handier ship would have the advantage of striking the other ship on her bow with her stem, which is a totally different thing. If I found I could not do that, the two bows would come together, and then the strongest bow would still have the advantage. Whoever first made up his mind to put his helm hard over would have the start; then whoever had the handiest ship would have another start, and the consequence would be, if those two bows came together, one with the stem against the bow, that ship would have an enormous advantage, and would drive a hole in the other. I consider the result of the discussion to have been greatly to my satisfaction. It has led to some very useful remarks, and I hope some good will come from it. I do not think our bows are strong enough, and I think there should be two classes of armour-clads, because a fleet action requires a totally different class of ship to those suited for single action. Then with regard to what Captain Colomb said about speed. I quite agree that we studied to give great speed to our late designs for large ships, but not to our small craft, which is a great mistake. It is perfectly useless building ships with 9 or 10 knots speed. Why not have vessels like the Admiralty yachts, to go 16 and 18 knots? There is no reason why they should not carry guns, and though they might be more expensive than the sloops we are now laying down, they would be cheaper in the end. These small craft that we are now building would all be captured at the beginning of a war, and we are doing this with our eyes open.

TABLE VIII.[1]—*Comparative Strength of the Regular Cavalry, including Depôts, as it was in* 1881 *and as it will be in* 1886.

	War.	Peace.
1881.		
Service squadrons—		
Combatants	41,746	41,700
Non-combatants	5,280	4,948
Horses	35,500	33,316
Depôt troops—		
Combatants	29,008	11,328
Non-combatants	1,344	2,864
Horses	20,480	6,944
Grand total—		
Combatants	70,754	53,028
Non-combatants	6,624	7,812
	77,378	60,840
Horses	55,980	40, 260
1886.		
Service squadrons—		
Combatants	52,354	58,286
Non-combatants	1,838	3,880
Horses	55,910	49,196
Depôt troops—		
Combatants	28,280	4,832
Non-combatants	4,938	686
Horses	23,856	5,544
Grand total—		
Combatants	80,634	63,118
Non-combatants	6,776	4,566
	87,410	67,684
Horses	79,766	54,740

N.B.—Our estimate of the prospective increase to the Russian Cavalry in Parts I and III of this article was too high. The normal strength of the Cavalry Division in war-time will be—

Combatants	3,776
Non-combatants	167
Total	3,943
Horses	3,638

[1] Inadvertently omitted from the "Addendum to the Article on the Russian Army in 1882," published in No. CXXV of the Journal.—ED.

The positive increase to the whole available cavalry force of the field army will be about 15 per cent.

Augmentation to the Number of Rifle Battalions.

A second brigade of rifles is to be formed in Siberia, consisting, like the 1st, of four battalions.

The number of rifle battalions in the Russian Army will thus be increased to 54.

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Rogers, E., F.R.G.S., Major, Staff Officer of Pensioners, Manchester
Goldsworthy, W. T., Col. late Essex Regiment (56th)
Robertson, A. Cuningham, C.B., Lieut.-Genl.
Petrie, M., Col.
Griffiths, E. St. J., Colonel late 1st Batt. Yorkshire Regt. (19th)
Bateman, H. W., Major Army Pay Dep. late 31st Regt.
Maclean, H J., Colonel late 3rd Batt. Rifle Brigade
Stawell, W. St. Leger Alcock, Lieut.-Col. late 9th Batt. King's Royal Rifle Corps
Meaden, J., Lt.-Col., late Ceylon Rifles
East, C. J., Brigadier-General, Bengal
Lock, A. C. K., Colonel 4th Regtl. District
Woodgate, E. R.P., Major Royal Lancaster Regt., Brigade Major, Jamaica
Thompson, R. T., Lt.-Col. h.p. 2nd Batt. Essex Regt., Commandant School of Music, Kneller Hall
Mackinnon, W. C., Major Assist. Adjt.-Gen., Bengal
Walton, C. E., Assist. Commissary-General.
James, Walter H., Capt. late R.E.
Hozier, J. W., late Lt.-Col. Scots Greys
Barker, G. D., Col., Assistant Adjutant-General West. Divn.

INDIAN FORCES.

Birch, W. B., Major Bengal Staff Corps
Fosbery, G. V., V.C., Lt.-Col. late Bengal Staff Corps
Gordon, J. J. H., C.B., Brigadier-General Bengal Staff Corps
Lloyd, E., Captain 1st Punjaub Cavalry.
MacGregor, Sir C. M., K.C.B., C.S.I., C.I.E., Maj.-Gen., Quarter-Master-General, Army Head Quarters, India
Neave, E. S., Major 18th Beng. Cav.
Bythell, R., Lieut.-Colonel Bombay Staff Corps
Ostrehan, E. S., Lt.-Col. Bom. Staff Corps
Watts, J. G., Colonel Bombay Staff Corps
Cologan, J. F. Fitzgerald, Lieut.-Col. Bengal S.C.
Sewell, H. Fane H., Lt.-Col. Madras Staff Corps, Hyderabad Contingent
Clutterbuck, T. St. Q., Major Bengal Infantry
Prendergast, G. A., Col. Bengal Staff Corps
Heyland, A. Rowley, Major 1st Bombay Lancers
Collen, E. H.H., Major Bengal S.C., Deputy Secretary, Government of India
Macaulay, G. W., Lt.-Col., late Comt. 1st Scinde Horse
Crookshank, A. C. W., Lt.-Col. Bengal Staff Corps, Assistant Military Secretary, Government of India
Travers, E. A., Capt. Ben. S.C.

YEOMANRY CAVALRY.

Craft, R. B., F.L.S., F.R.M.S., Major Herts
Mildmay, Sir H. B. P. St. John, Bart., Colonel late Hampshire
Portman, Hon. W. H. B , Col. late West Somerset.

HON. ARTILLERY COMPANY.

Raikes, G. A., Major, late Instructor of Musketry.

VOLUNTEER CORPS.

Artillery.

Pooley, H., Captain late Cheshire
Rutley, J. Lewis, Major 2nd Middlesex

Engineers

Macliver, D., Lieut.-Colonel 1st Gloucester

Rifles.

Clinton, Lord E. W. P., Lt.-Col. Com. 1st City of London, late Rifle Brigade
Yorke, P. C., Major and Adjt. 1st Bucks
Acland, Sir Thomas Dyke, Bart., M.P., Col. 3rd Devon
Davidson, D., C.B., Col. Edinburgh City
Twyford, H. B., Lieut.-Col. late Hampshire
Hardinge, C. S., Viscount, Col. A.D.C., 1st Kent
Sweny, Eugene, Capt. 3rd Kent
Crawley, T. G. Major, 8th Foot and Adjt. 7th Lanark
Hutchinson, J., Hon. Col. 1st Vol. Batt. Lanc. Fusiliers
Halford, Sir Henry St. J., Bart., Lieutenant-Col. 1st Vol. Batt. Leicestershire Regt.
Vickers, C.B., Lt.-Col. 10th Vol. Batt. K.R.R.C.
Tomkins, A. S., Capt. late 1st Middlesex Victorias
Fordyce, A. D., Lt.-Col. 3rd V. B. Gordon Highlanders.
Verity, C. F., Major late 2nd South Middlesex
Page, Sam. Flood, Major late London Scottish
Lombard, G. C. S., Major and Adj. 5th Vol. Batt. K.R.R.C.
White, C. W., Capt. 8th Vol. Batt. K.R.R.C.
Roupell, C. M., Capt. late 23rd Inns of Court
Enfield, Viscount, Honorary Col. 4th Vol. Batt. Middx. Regt.
Baylis, T. Henry, Q.C., Lt.-Col. late 18th Middlesex
Cronin, Alfred C., Capt. 19th Middlesex
Leighton, Sir Fredk., Colonel 20th Middlesex, P.R.A.
Alt, W. J., Lt.-Col. 22nd Middlesex
Vincent, C. E. Howard, late Lieut.-Col. 13th Middlesex
Wright, C. I., Lieut.-Col. late Nottingham
Thomas, W. H., Capt. late 1st Surrey
Dartmouth, Earl of, Capt. late Stafford
Rouse, Rolla, Major late 2nd Suffolk
Harding, Charles, F.R.G.S., Major late 19th Surrey
Longstaff, Llewellyn W., F.R.G.S., Lieut.-Col. late 1st East York

COLONIAL RESERVE FORCES.

Militia.

Gore, Augustus F., C.M.G., Lt.-Governor of St. Vincent, Lt.-Col. Barbadoes and British Guiana.
Brunel, A., Lt.-Col., Active Militia, Canada, Lt.-Col. Colonial Reserve Forces, F.R.G.S.
Montizambert, Charles E., Lt.-Col., Captain B. Battery, School of Gunnery Quebec.
Imlack, R. W., Col., British Guiana.
Turnbull, J. F., Colonel Canadian Hussars
Sargood, F. T., Major Victoria Field Artillery, Melbourne.
Disney, T. R., Col. Com. Local Forces, Victoria.
Walker, A. G., Lt.-Col., Staff Officer for Artillery, Victoria.

GOLD MEDALLISTS.

Military.

1875. Captain H. W. L. Hime, R.A.
1877. Lieut. John Ross-of-Bladensburg, Coldstream Guards.
1879. Captain Emilius Clayton, R.A.
Major T. Fraser, R.E.
1881. Captain J. K. Trotter, R.A.
1883. ——

Naval.

1876. Commander G. H. U. Noel, R.N.
1878. Captain P. H. Colomb, R.N.
1880. Captain the Hon. Edmund R. Fremantle, C.B., C.M.G., R.N.
1882. Captain Lindesay Brine, R.N.
1884. Captain Charles Johnstone, R.N.

1884–85.

Subject for the Military Prize Essay :—

"Should the European Army in India continue as at present constituted, or should it be converted in whole or in part into a local force ?"

ERRATA.

Journal No. cxxiii, page 214. Foot Note.

For "in the formula $N_s = \frac{2\pi R \times 3600}{V' \times 1851{\cdot}85} + \frac{\theta}{360}$ the units are French, R being the number of mètres in a knot," read "in the formula $N_s = \frac{2\pi R \times 3600}{V' \times 1851{\cdot}85} \times \frac{\theta}{360}$ the units are French, R being expressed in mètres and 1851·85 being the number of mètres in a knot."

Page 219, under head "Data." For "$N_s = 54$" secs., read "$N_s = 45$." Also on line 25, for "Log. $V' = \log. R + \log. \theta + \log. 034 - 45$," read "Log. $V' = \log. R + \log. \theta + \log. 034 - \log. 45$."

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OF THE
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Friday, May 9, 1884.

CAPTAIN THE RT. HON. LORD CHARLES W. D. BERESFORD, R.N., in the Chair.

TORPEDO-BOATS, HAVING SPECIAL REFERENCE TO THOSE BUILT BY MESSRS. YARROW AND CO.

By A. F. YARROW, Esq., Member Institute of Civil Engineers; Member Institute of Naval Architects.

I DO not propose in this paper to deal with the earliest attempts at torpedo-boat construction, but will commence at a date when the importance of these vessels for naval warfare was first prominently brought forward, and when the first large order for them was given. It was in 1877 that the authorities in St. Petersburg required no less than 100 torpedo-boats; these were to be of the smallest possible size, suitable for keeping the sea for a few days, and at the same time adapted for transmission by rail from the Baltic to the Black Sea. With this view, dimensions of 75 feet in length by 10 feet beam were determined upon. These boats were contracted for by seven different firms, with two exceptions all in Russia, the Baltic Engineering and Shipbuilding Company at St. Petersburg receiving orders for the greatest number. The Russian authorities applied to us to supply them with as many sets of machinery as we could get ready before the closing of the navigation on the Baltic, and also to furnish complete working drawings of the machinery and the hulls, from which a large number of the vessels could be immediately put in hand. In November, 1877, the trial of the first boat took place on the Neva, when a speed of 18 knots was obtained. The completion of the others followed in rapid succession, and I would here observe that the credit for the speedy and successful completion of them, at a time when their construction was little understood, is mainly due to Mr. Kasy, the energetic manager of the Baltic works.

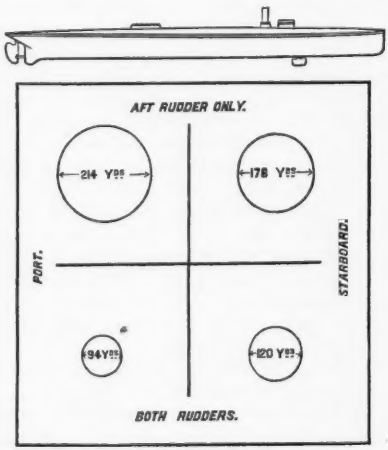
Several of these boats were forwarded by rail from St. Petersburg to Sebastopol, with only the funnel removed to allow free passage under the bridges; "they took a week in transport, and arrived in such good condition that immediately on being launched into the waters of

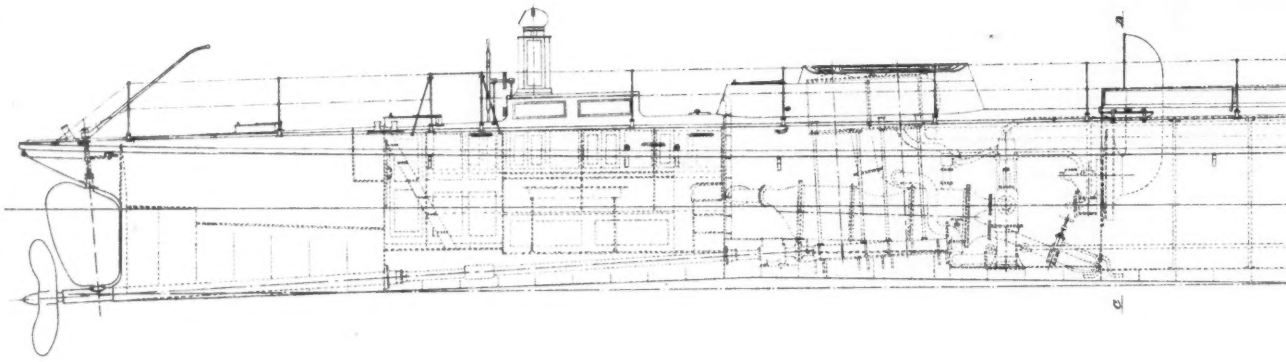
the Black Sea from the railway trucks they were tried under steam with entire satisfaction, and proved to possess much better sea-going qualities than was anticipated."

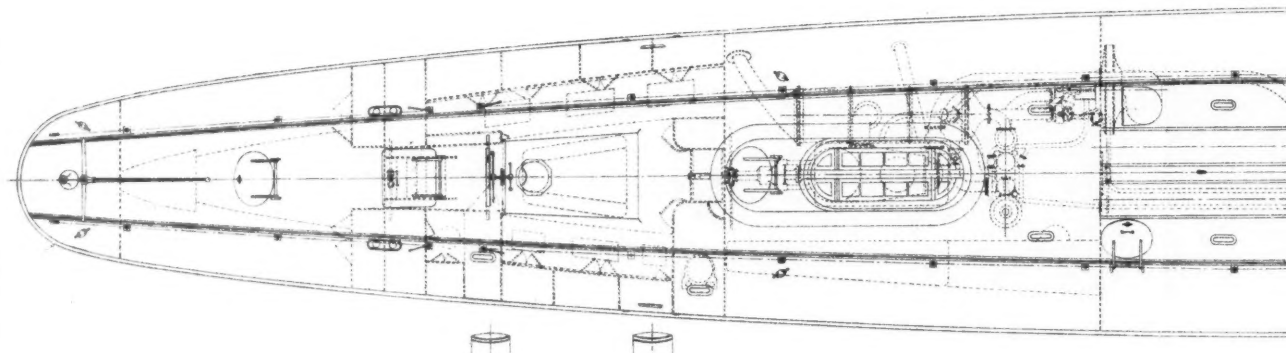
The speedy completion of these boats serves to show how quickly a fleet of torpedo-boats was constructed at that time, when the subject was comparatively new; it also illustrates with what rapidity, if proper appliances are at hand, they can be safely transported long distances overland.

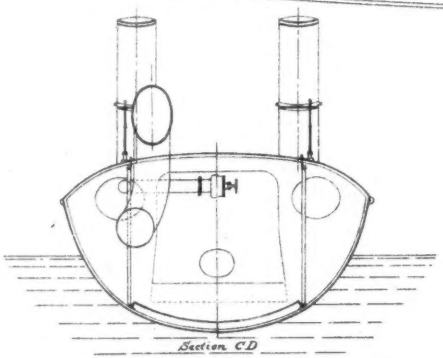
About this time the English Government ordered a number of first-class torpedo-boats similar to the "Lightning." A few months later, early in 1878, some further orders were distributed for similar vessels among various firms, we receiving instructions to build one, to be of the same dimensions as the other first-class boats then in hand. Our boat was completed in the spring of 1879, and, on trial at Long Reach under the Admiralty conditions, a speed of 21·94 knots was obtained. The highest speed realized at that time by other firms in these boats on the same conditions was 19 knots, therefore it will be seen that this trial records an advance of practically 3 knots beyond what had been done before. The load carried during the trial was $6\frac{3}{4}$ tons, representing the weight of torpedoes, gear, coal, &c. Although similar boats have been supplied since, I believe this one still maintains its position as the fastest in the British Navy.

After this boat had been tried, with a view to improve its steering capabilities, we obtained permission to fit to it a forward rudder, and a set of experiments were tried by the Admiralty to test the influence this bow rudder had on the manœuvring capabilities of the boat. As the results obtained are instructive, I propose to give a brief description of them, and beg to refer to the following diagram. The forward rudder was partially balanced, and









THE "B

THE FIRST SEA GOING TORPED
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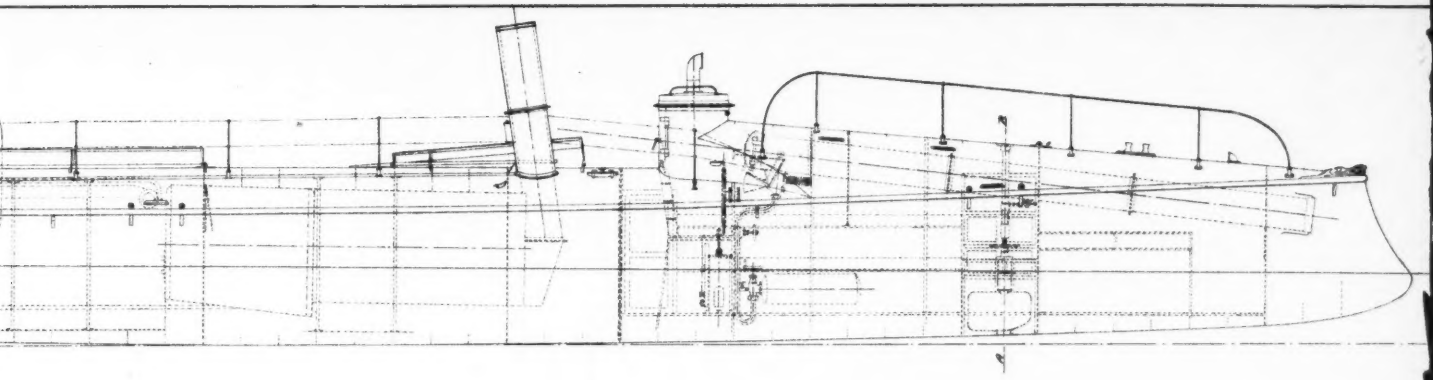

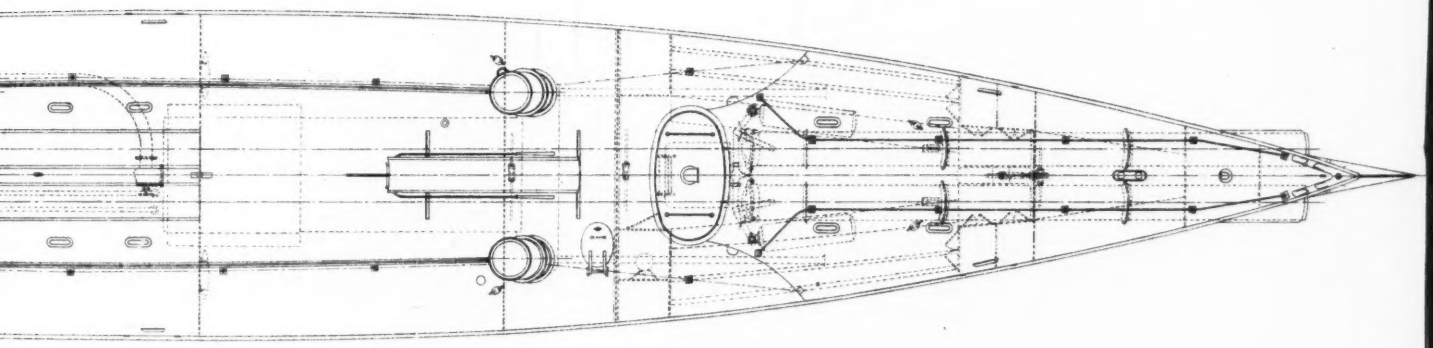

THE "BATOUM"

ING TORPEDO BOAT EVER BUILT. SHE STEAMED
LONDON TO THE BLACK SEA IN 1880.

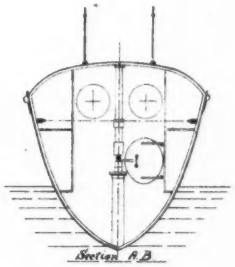

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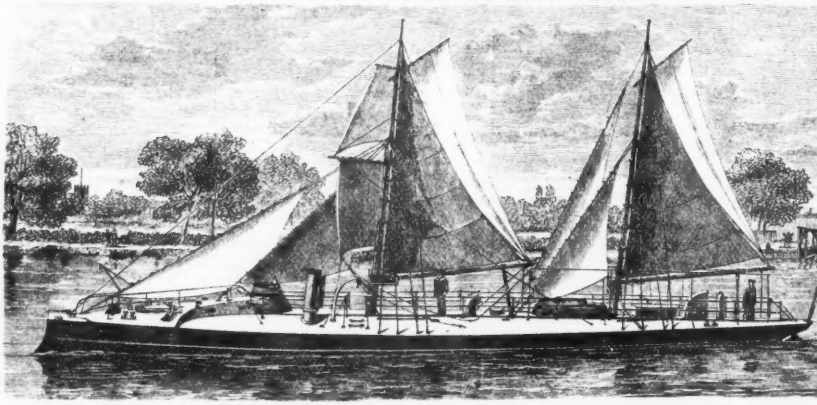
FIG. 1
THE ARGENTINE TORPEDO BOAT "ALERTA."



A TORPEDO BOAT COLLISION.

FIG. 3.

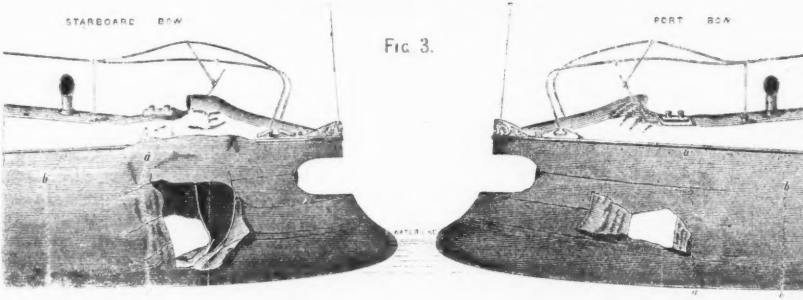


FIG. 4.
TORPEDO BOAT FOR THE BRAZILIAN GOVERNMENT.

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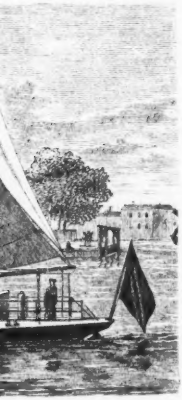
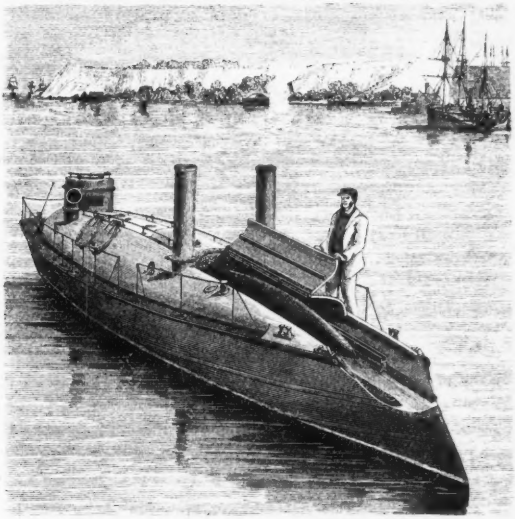
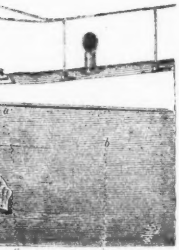
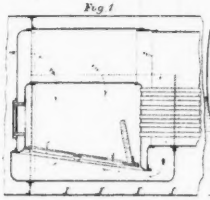
FIG. 2.

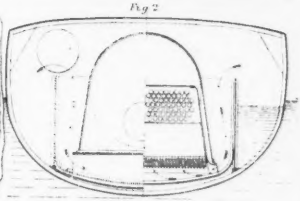
TORPEDO BOAT WITH STEAM IMPULSE GEAR.











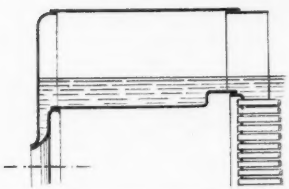
TORPEDO BOAT FOR THE ITALIAN GOVERNMENT.

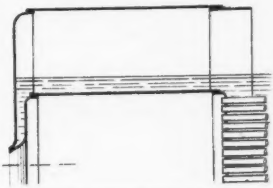
Which obtained 22·4 knots on trial.

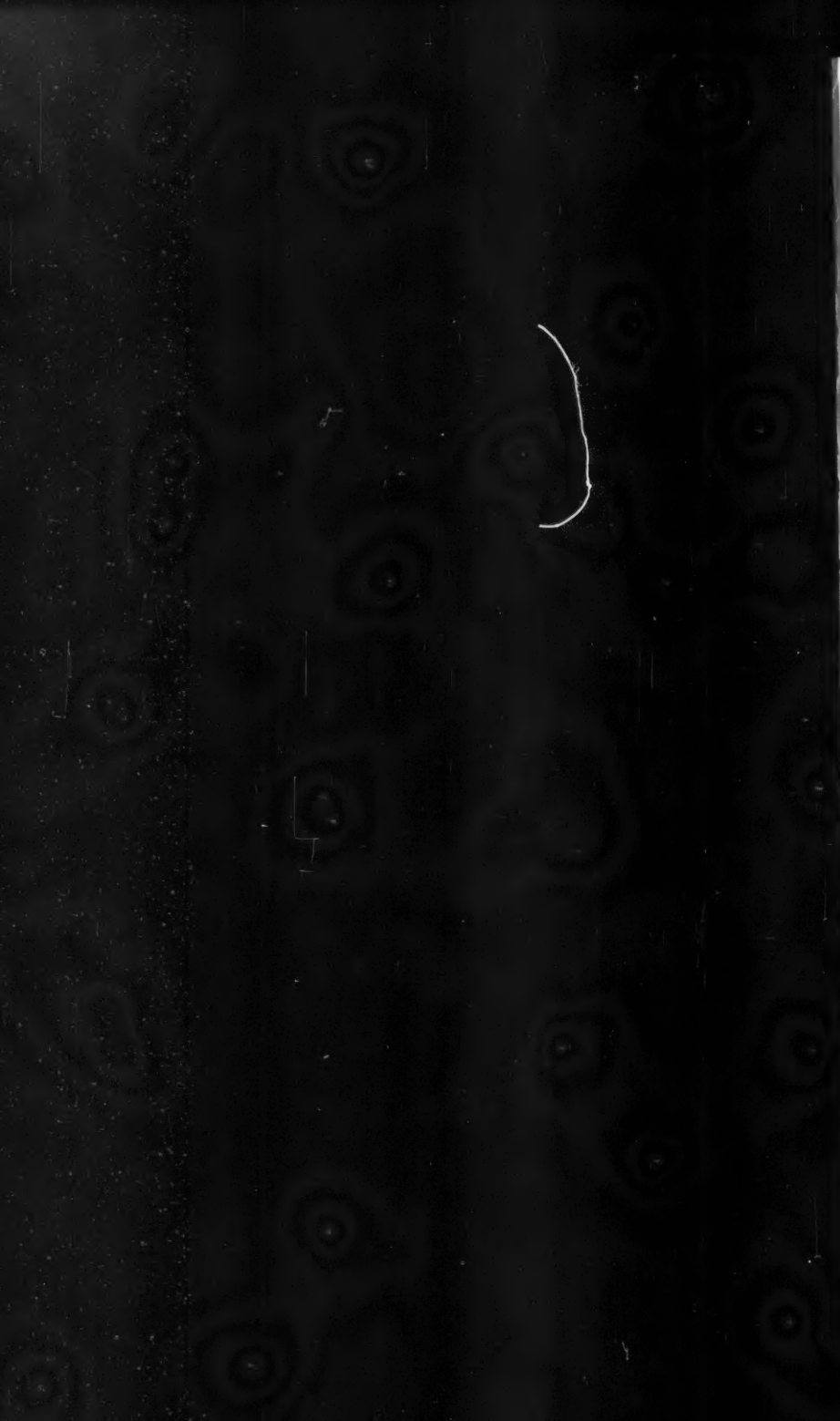
"YARROW" TYPE OF FURNACE.

FIG. 5.

ORDINARY TYPE OF FURNACE







arranged to slide within the boat in the same manner as a centreboard. Circles both to port and starboard at full speed and half speed were made, first with the stern rudder only (the forward rudder being pulled up within the hull), and then with the two rudders worked in conjunction; the results are illustrated by the large and small circles respectively. These are drawn to scale on the diagram, and show at a glance to what an important extent the steering capabilities of the boat were improved by this system; the result has been the general adoption of it in all torpedo-boats, excepting only those of the smaller class. This forward rudder not only improves steering when going ahead, but enables the craft to be under control when going astern, which otherwise would be impracticable.

In the year 1878 we built two first-class torpedo-boats for the Russian Government, which it will be remembered were not allowed to leave this country, and eventually were purchased by the Admiralty. On the official trial of one of them, an accident occurred by the rupture of a boiler tube, which might have resulted in loss of life, had not provision already been made by us to guard against the danger resulting from such an occurrence. Similar accidents had already occurred with fatal results abroad, and in our own Navy, men have been seriously scalded from the same cause. Not only was life endangered, but whenever these boats were required to be worked up to their greatest speed, the stokers became naturally unwilling to urge the boilers to their full extent, and the efficiency and speed of the boats consequently suffered. These accidents were most frequently due to the boilers giving out where the tubes join the tube plate; the water suddenly and without warning issuing out into the fire, causes an immediate rush of flame and superheated steam to pass through the fire, forcing its way into the stokehole.

The essential feature in the arrangement introduced by us to overcome this danger was to cause all the air which was forced from the fan to the fire to pass on its way through light non-return valves, arranged so that if the flame or steam from any cause had a tendency to rush back, the valves would immediately close and at once cut off any connection between the boiler and stokehole.

The efficiency of this plan was unexpectedly tested on the trial of one of the boats last referred to; and the necessity for such an arrangement was so clearly proved to the satisfaction of the Admiralty officials on board, that instructions were issued for all boats working under a forced draft to be fitted with some method for effecting this purpose, and this system has now become generally adopted in modified forms by torpedo-boat builders.

I will now pass on to the end of 1879, when we concluded a contract with the Russian Government for a torpedo-boat of larger dimensions than any that had been constructed before, it being desired by the authorities that it should be a sort of torpedo cruizer, capable of going out to sea in any weather, and have coal-carrying capacity sufficient to make a run at a moderate speed of at least 800 miles. This little vessel (referring to model), the "Batoum," is represented in Plate XVI. It was 100 feet in length by 12 feet 6 inches

beam, was provided with engines capable of indicating about 500 horse-power, and adapted for carrying four fish torpedoes, which it will be seen can be passed through the conning-tower into the two launching tubes, which were supplied by Mr. Whitehead. They were placed side by side parallel to the centre line of the boat, and projected just outside her bow. This discharging gear, which was entirely under the control of the steersman in the conning-tower, it will be seen is below the forward deck, and therefore well under cover.

There was a cabin aft for the Officers, and quarters forward for the men, which were as capacious as a vessel of these small dimensions would admit. There were three short masts and sails, temporarily fitted as a precautionary measure in case the machinery broke down, or the coal supply ran short.

She left England in August, 1880, having a crew of three Officers and nine men, and steamed from London to Nikolaief, exclusive of stoppages, in eighteen days, the distance run being 4,800 miles (including calling at Fiume on the way), being an average speed of 11 knots an hour. Our contract with the Russian Government was to give a speed, light, at the measured mile of 20½ knots, but on trial 22 knots were obtained.

Some interesting experiments were made with this boat before it left, to test the reduction of speed due to increased displacement, and it was found that up to 15 tons load, there was a loss of speed at the rate of one-fifth of a knot per ton, or from one-third to two-fifths of a knot for every inch increased draft.

This little vessel, which was the first torpedo-boat to successfully make a voyage of any duration, has evidently been considered by many Governments to be worthy of reproduction, judging by the numerous orders we received soon after its construction, from the Argentine, Greek, Brazilian, Austrian, Dutch, and Italian Governments. In fact, it may be said to have given rise to an altogether new type of sea-going torpedo cruizer.

I would here mention that the four boats of this class built by us for the Argentine Government were rigged, as shown by the model, with a view to enable them to cross the Atlantic under sail alone. They all arrived safely, and one, the "Alerta," (Fig. 1, Plate XVII), made the voyage from Plymouth to Buenos Ayres in seventy-two days.

As to the sea-going qualities of this class of boats, I cannot do better than read an extract from a letter from the Captain in command of one of them:—

"After having steamed out one of the torpedo-boats, constructed by you for the Greek Government, from London to Fiume last year, and having sailed in command of one of those you constructed for the Brazilian Government this year to Rio, I have no hesitation in saying that their sea-going qualities are exceptional. On both voyages we encountered very rough weather, and in the case of the Brazilian we were laid to off Cape Frio in a heavy S.S.W. gale of such a force I have not experienced the like for twelve years, and she behaved admirably."

I draw attention to the seaworthiness of these vessels simply to

show there is no occasion for an increase in their dimensions in order to render them thoroughly safe. The only advantage of larger size is greater accommodation and more comfort for the Officers and crew, and longer steaming capabilities.

This "Batoum" class of boat I think has proved itself capable of independent offensive action in any weather, and would consequently seem to be admirably adapted for harbour and coast defence in cases where a coal supply is only necessary for cruizing about, never being absent from a port of call more than a few days.

In the years 1879–1880 the Admiralty required thirty-four second-class torpedo-boats to serve as part of the equipment for their large ironclads; these were ordered chiefly from Messrs. Thornycroft and Co., and some from us.

I may here mention that at this time the usual mode of arming this class of torpedo-boat was by fitting skeleton steel cradles or frames suspended by davits on each side of the boat; into these cradles the torpedoes were placed, and by a very ingenious arrangement, introduced by Mr. Thornycroft, they were lowered into the water. When the torpedo was completely immersed, it was allowed to pass out of the cradle by its own mechanism, taking a direction parallel to the boat itself, and good practice has been made with this system. In order, however, to use it successfully, the torpedo-boat must be brought almost to a state of rest; which, as well as the lowering process, causes considerable delay, which is clearly objectionable.

With a view to introduce a more efficient system, we fitted up a small launch with temporary steam impulse gear, which was tested in the presence of the Admiralty authorities, who were sufficiently well pleased with the arrangement to induce them to give instructions for all second-class boats then on order by Messrs. Thornycroft and ourselves, but not commenced, to be fitted with this plan.

It is illustrated by the model on the table (Fig. 2), and consists in building into the forward part of the hull two troughs parallel to each other, in which the two torpedoes lie ready for use. Immediately behind and under a steel covering are a couple of impulse tubes, consisting simply of two long thin steel cylinders, provided with pistons and piston rods, which press against the after end of the torpedoes. The impulse gear is so arranged that at the will of the Officer in charge either one or both of the torpedoes can be instantly ejected by steam supplied by the main boiler, without requiring any reduction in speed in the boat or necessitating the presence of any of the crew on deck. I believe this impulse gear is lighter than any other, and avoids the necessity and complication of carrying air-compressing machinery, which would be heavy for boats of this small displacement.

The highest speed obtained in this little fleet of thirty-four second-class boats was by one of those built by us, 17·27 knots being realized during a continuous run of two hours, loaded in accordance with the Admiralty regulations.

I would now refer to Fig. 3, illustrating the result of a colli-

sion between two of our boats constructed for the Italian Government, which took place while they were manœuvring in the Bay of Spezia. To fully explain the circumstance, I will read an extract from Rear-Admiral Racchia's letter, in which he described it:—

"Unfortunately, one of your boats was run into, and is now under repair, but the other boat—the one that ran into it—was only very slightly damaged. The repairs were made in a week, and she is still in commission and doing very well. The sketch shows the fore part of the 'Falco,' the one which was run into, so that you may form yourself an idea of the damage sustained. At the time of the collision, which took place inside the breakwater, the two boats were running at a speed of nearly 14 knots, which was perhaps reduced to 10 knots at the actual instant of collision. The 'Falco' was saved from sinking by the watertight bulkhead, as she was struck just a few inches forward of it. The fore end of the ram of the other boat went right through the starboard side out beyond the port bow of the 'Falco.' However, the latter steamed on, and reached the dockyard safely. Her machinery sustained no damage whatever, which was entirely confined to the bow and launching tubes."

Collisions between torpedo-boats, even in times of peace, seem to be by no means uncommon, and it is not unnatural to suppose that in war ramming may be one of the most efficient means of attack between the boats themselves. From this cause and from the shots of machine-guns there exists doubtless great danger. If a boat is damaged and water finds access to any of the compartments forward or aft of the boiler space, it is more than probable, as in the case illustrated, it would be able to reach a place of safety under its own steam. If, however, the boiler compartment, embracing as it does generally the stokehole, is damaged, and an influx of water take place in consequence, it only requires, as boats are generally constructed now, that it should rise but a very few inches to completely destroy the steaming capabilities of the boiler from the following cause. The bottom of the firebox is kept, for reasons of stability, as near the keel of the boat as possible. The air needed for combustion enters below the fire-bars, and consequently, as soon as the water has risen in the stokehole through such an accident as we have assumed, to the level of the bottom edge of the fire-box—in fact even before the water comes into contact with the fire itself—it shuts off the air supply, putting an end to any further generation of steam. This at once renders the boat powerless, and in fact all the elaborate steam pumping apparatus with which they are generally provided is, in consequence, useless, and the boat in such a case, although the damage might be small, would remain powerless and at the mercy of the enemy.

We now adopt an arrangement which materially reduces this source of danger. It consists in completely enclosing the fire-box with a watertight casing, designed in such a manner that the air supply is forced to enter above the possible water level in the stokehole, should it be flooded (see Plate XVII, small Figs. 1 and 2). By this means the air supply is maintained, and the water is completely prevented from gaining access to the bottom of the fire-box, the steaming

Report of Trial of First-class Torpedo-boat No. 535, at Long Reach, December 13th, 1881.

Length of boat 100 feet, beam 12 feet 6 ins. Built for the Royal Italian Government by Yarrow and Co.

No. of run.	Steam in boiler.	Pressure in receiver.	Vacuum.	Revolutions.		Time.		Speed.	Mean speed.	Speed ascertained by mean of means.
				Per knot.	Per minute.					
			inches.			mins.	secs.			
1	115	35	25½	1,340	480	2	48	21·428		
2	118	35	25½	1,237	470	2	38	22·784		
3	120	35½	26	1,336	480	2	47	21·556	22·46	22·36
4	116	35½	25½	1,240	480	2	34	23·376		
5	115	36	25½	1,370	485	2	49	21·301		
6	115	36½	25½	1,200	487	2	28	24·324		
Means.	116½	35½	25½	1,287	480	..		..		

power remaining unimpaired so long as the fuel on the fire-bars lasts. As these boats when running have from 10 to 12 cwt. of coal on the bars, and as it is found by experiment that in a 100-ft. boat under 2 cwt. is sufficient for an hour's run at a 10-knot speed, it follows that steaming power would be maintained for several hours under these conditions, and what perhaps is of equal importance, it gives time to possibly repair the damage, and to get the bilge pumping arrangement into full work.

It has been suggested that this arrangement would somewhat check the air supply and impair the maximum speed. In proof that this is not found to be the case, I annex particulars of the official trial with one of our boats fitted in this manner. I give the result in detail as it perhaps might be considered of special interest, being, so far as I am aware, the highest recorded on any official trial, the mean of the runs showing a speed of 22·4 knots.

The trial was attended by Rear-Admiral Racchia, Captain (now Admiral) Noce, and Chief Engineer Nagar, on behalf of the Italian Government.

Draught forward 2 feet 3, draught aft 3 feet 6. Propeller 2-bladed, 4 feet 7 diameter, 6 feet pitch, 860 square inches area, mean slip of screw 21 per cent. Weather fine, two torpedo-guns with air compressor, &c., complete on board, in addition to which 3 tons 13 cwt. was carried made up as follows :—

	Tons.	Cwt.
Coals	1	15
Water in tank	0	6
Anchor and chain.....	0	4
Stores.....	0	3
Nineteen men	1	5
Total	3	13

In these boats we arranged the forward ends of the launching tubes so that they came within the lines of the hull, it having been found that when they project considerably, as up to this time was the case, great inconvenience was caused in rough weather through the waves striking them.

The model on the table (see Fig. 4) represents one of four boats built by us for the Brazilian Government, 110 feet long by 12 feet 6 inches beam. They were all navigated safely from London to Rio under sail alone. For this purpose the propellers were removed, and in order to give them better sailing capabilities, a deep temporary wooden keel was provided amidships, extending along about half the length of the boat.

The contract stipulated that these boats should have a speed of 18 knots, during a continuous run of three hours with a load of $12\frac{1}{2}$ tons, representing their fully equipped state ready for action. This, however, was considerably exceeded, and in the best of the four boats 20·3 knots was obtained, which I believe is the highest speed officially recorded under such conditions of trial.

I beg here to draw attention to the shape of deck we invariably adopt. It will be seen from the models to be curved, which we believe is a stronger form than any other, because the strain the deck is most subject to is one of compression, which clearly a curved plate is better calculated to withstand than a flat one, consequently either greater strength with the same weight, or the same strength with less weight, is obtained.

During last year no special improvements in torpedo-boats have been made. I would, however, refer to two sea-going boats built for the Russian Government by Messrs. Thornycroft and Co., and by M. Normand. The one by the former firm was 113 feet long by 12½ feet beam, and on trial obtained a speed of 18·96 knots per hour during a run of three hours' duration, the consumption being 2 tons 19 cwt., with 633 I.H.P., or at the rate of one ton per hour. Another trial was made to test the consumption when steaming slowly, and it was found that at a speed of 13·39 knots the coal burnt was 13 cwt. 3 qrs. 8 lbs., during two hours, the power indicated being 212 I.H.P.

With M. Normand's boat, which was 124 feet by 11 feet 8 inches, a speed of 18½ knots per hour was obtained during a run of three hours, the consumption being 1 ton 19 cwt., and the power 574 I.H.P. During a four and a half hours' trial at a speed of 11·57 knots, the consumption was 240 lbs. per hour, the indicated power being 121.

In the Thornycroft boat, Nixon's navigation coal was used, and in the Normand boat, patent fuel; I refrain from drawing any comparison with regard to the consumption of these two boats, because without knowing the relative heating values of these fuels, it would be unreliable.

I would here allude to a feature in the French boat specially worthy of attention, and that is its great steadiness and the comparative absence of vibration when under weigh. Whether this is due to the slower number of revolutions of the engines, or to the greater strength of construction of the hull, or to other causes, I cannot say. It is, however, a point of some importance.

At the present time, it has become the custom of some Governments to require a run of three hours' duration, and I would observe that under these conditions it really does not become a test of the machinery so much as a test of the endurance of the men, which is, I presume, not the object of the trial. I believe, from actual experience, that men confined in the closed stokeholes and engine-rooms of torpedo-boats an hour and a half, is as much endurance as can be expected from anyone.

I would draw attention to one feature in the design of our boilers, which we have adopted for some time, and beg reference to the longitudinal sections (Fig. 5), from which it will be seen that the fire-box top is not flat as usual with other boilers, about 80 per cent. of it being at a lower level; the benefit arising from this arrangement is that it admits of a certain amount of a longitudinal elasticity which is very necessary wherever large and sudden fluctuations of tempera-

ture take place; it also allows greater depth of water over the crown, which, when flat, becomes at times partially uncovered when the boat is pitching, which, being immediately over a fierce fire, is most dangerous.

At the present moment we are building for the English Government two first-class torpedo-boats. They are 113 feet long by 12½ feet beam. Our contract is that they shall maintain a speed of 18 knots fully equipped, conditions which no doubt can be easily complied with.

The forward part of the boat is provided with two torpedo-guns. There is nothing very special in reference to these boats to distinguish them from the "Batoum" and others which we have built, except that they are somewhat larger, and are to be provided with a revolving torpedo-gun aft. They are, I believe, intended to be hoisted on board a large vessel, so that they can be transported to foreign parts without depending upon their own steam or sail power.

As regards the armament of sea-going torpedo-boats, it has hitherto been the custom to fit only two Whitehead torpedo-guns at the bow; and I would submit that the value of the torpedo-boat as a fighting machine would be greatly augmented by increasing the number. To illustrate this, I beg reference to the models.

I believe an important point to aim at in a torpedo-boat is to arrange the discharge of the torpedoes so that when the favourable opportunity does occur it should be made the most of, which can be best done by having the greatest number of torpedoes ready and available for discharging without a moment's delay.

The question has often been raised as to how far a torpedo-boat can be protected by partial armour, and after having carefully investigated this subject, we came to the conclusion that, with a length of 160 to 170 feet and a beam of 19 to 20 feet, we could with 1,200 I.H.P. obtain a speed of 19 knots, having the central portion of the boat enclosing the machinery and magazine and launching apparatus completely encased—the sides with steel plating 1½ inch thick, and the deck with plating 1 inch thick, this armoured part having sufficient buoyancy to support the ends if filled with water. No doubt these thicknesses are very far from proof against the shots of machine-guns, if hit under conditions favourable to the gun. This, however, we may reasonably suppose would rarely be the case. A torpedo-boat would probably attack end on, it would be, say, a quarter of a mile distant, consequently any shot that strikes it from the vessel that is the subject of its attack would hit either the deck or the side at a very acute angle.

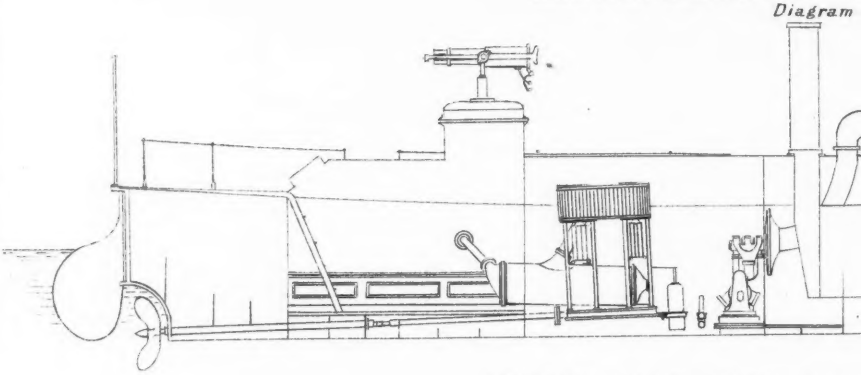
I wish it to be understood that I am not advocating armoured torpedo-boats, for it is a question for naval authorities to decide, rather than constructors, how far this amount of protection is worth the additional cost and the additional size. The model I exhibit illustrates such a boat, and I would observe that in its design we are indebted, for many valuable suggestions, to Admiral Noce, of the Royal Italian Navy.

I should like to say a few words concerning the second-class

FAST MACHINE

LENGTH, 56 FEET. BEAM, 9 FEET. SPEED, 15 KNO

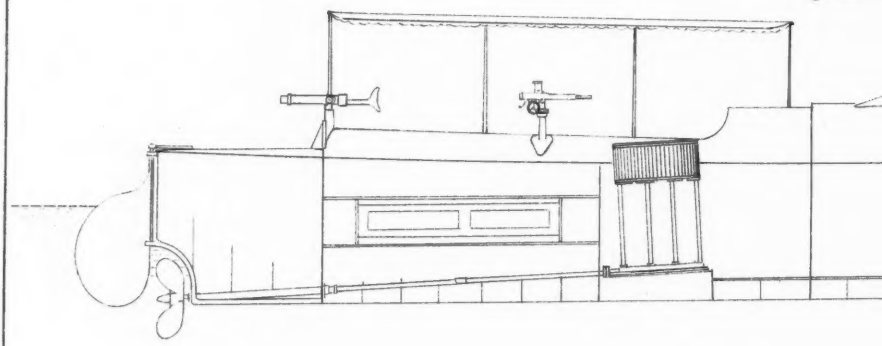
Diagram



COMBINED LAUNCH MACHINE GU

LENGTH, 56 FEET. BEAM, 9 FEET. SPEED, 15 KNO

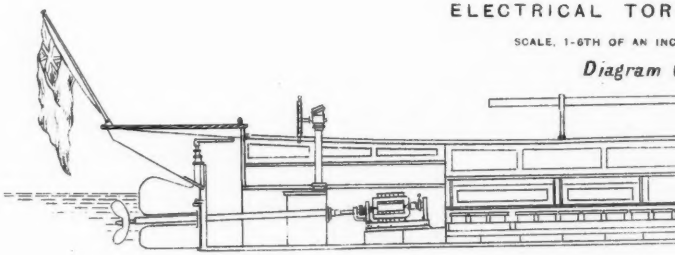
Diagram E



ELECTRICAL TOR

SCALE, 1-6TH OF AN INC

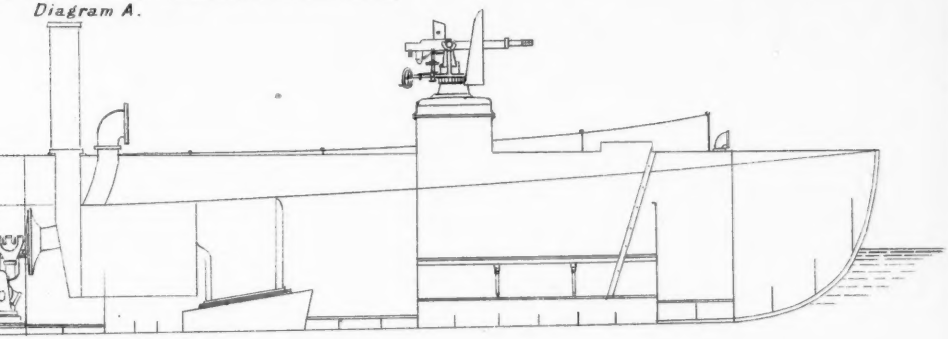
Diagram



MACHINE GUNBOAT.

ET SPEED, 15 KNOTS. SCALE, 1-6TH OF AN INCH TO 1 FOOT

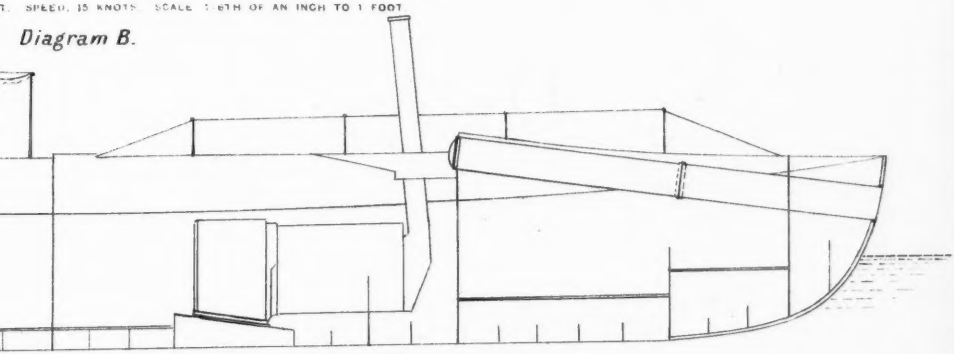
Diagram A.



ACHINE GUNBOAT AND TORPEDO BOAT

T. SPEED, 15 KNOTS. SCALE, 1-6TH OF AN INCH TO 1 FOOT

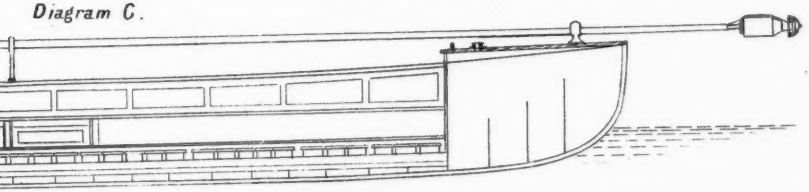
Diagram B.



ICAL TORPEDO BOAT

E, 1-6TH OF AN INCH TO 1 FOOT

Diagram C.



...ons, 240 & 42 Martins Lane W.C.

boats which are used on board large ironclads. These, if I understand rightly, ought to fulfil many other duties besides that of a torpedo-boat. They should primarily serve as guard or picket boats, to warn the ships to which they are attached of the approach and to protect them from the attacks of torpedo-boats, and it would add greatly to their general utility if they were designed to be also available as fast steam launches for the ordinary service of the ship.

I believe the second-class boat, of the length and beam (63 feet by 7 feet 9 inches) at present adopted, is not the best to secure the most suitable combination of good qualities, being too long, narrow, and very unhandy; it fact, it is clearly ill adapted and too delicate for the duties of a fast steam launch, for which, if of different proportions, it would be available.

I would now refer to the two diagrams, A and B, Plate XVIII, representing alternative types of boats, to be, say, 56 feet in length by 9 feet beam, having a speed of 15 knots, and I would submit to naval authorities that such boats as these would be well adapted for being supplied to ironclads, and perhaps more suitable than the second-class torpedo-boats with which they are at present supplied. The fast machine-gun-boat would be more efficient as a protection against torpedo-boats, owing to the machine-guns and the good position in which they are carried, and the other would combine the advantages of a torpedo-boat, a machine-gun-boat, and a fast steam launch, being very suitable for the ordinary services of the vessel, and I think that the qualities they possess of greater seaworthiness and general utility more than compensate for the small loss of speed due to the different proportions of length to beam.

In reference to this part of the subject, I should like to refer to the boats recently designed and built by Mr. White, of Cowes, which have remarkable powers of steering in consequence of the peculiar formation of the hull, and the system of rudders he adopts. I understand this gentleman has obtained exceedingly good results, in point of speed, and in conjunction with the remarks I have just made, I think they deserve special attention.

I must now say a few words concerning a difficulty which no doubt other torpedo-boat builders besides ourselves have found, viz., that although we may get good results on the Thames, when the boats are sent abroad we continually hear of their falling off in speed, resulting in more or less dissatisfaction on the part of the foreign authorities, the fault of which is frequently and wrongly attributed to the boats themselves.

Now, if we on a trial here can obtain for example a speed of 22 knots at Long Reach, or as in our Brazilian boats a speed of over 20 knots during three hours, fully equipped ready for action, I say that if precisely the same conditions under which those boats were tried here are repeated, the same results must inevitably follow. If a boat has only once obtained a certain performance, it is proof beyond all doubt what can be done, and if afterwards the boat is not driven at the same speed, it is no proof that it cannot go, but it is the clearest possible proof that the parties in whose charge it was at the time did not

know how to make it go. I submit this is thoroughly sound argument.

Among those Governments who have carefully trained men, and who have devoted special attention to the subject of torpedo-boats, such for example as the Austrians, I believe no difficulty whatever is found in obtaining results quite equal to what we secure on the Thames.

In proof of this I may refer to some recent trials at Pola of boats 100 feet in length by 12 feet 6 inches beam, which were constructed by us for the Austrian Government; they have attained a speed quite lately fully equipped with torpedoes, coals, and crew, in fact ready for action, of 20 knots. This in a boat of these dimensions, three years old, and with few exceptions identically the same as the "Batoum," I think reflects great credit upon the Austrian authorities, and is an undoubted proof what can be done when the boats are properly managed and in proper hands.

This subject leads on to show the necessity of having well-trained crews to manage these boats. In the Italian Service, for example, the authorities have organized a very complete and perfect system. Four or five torpedo-boats are commissioned at a time. They are forty-two days under steam; seven days out of this they are cruizing about at sea, running between Genoa and Leghorn and Spezia, averaging 14 knots; part of the time they are practising in the Bay of Spezia, launching torpedoes. They are continually being tested at the measured mile at their maximum speed, and in discharging torpedoes, not only do they fire at fixed objects, but also at moving ones. From what I myself have seen, I think that the success with which they launch their torpedoes illustrates in the clearest possible manner what continual practice may do.

In the Austrian Service they are continually running at full speed between Pola and Trieste, and Pola and Fiume, distances of 60 and 54 knots, in from three to three and a quarter hours, completely equipped. The results obtained by both these Governments can only be accomplished by good organization, and a careful system of training their crews in the management of these boats. I presume this matter is receiving the attention it deserves from the Admiralty authorities in this country, because however efficient and well constructed the English boats may be, or whatever care is taken of them, they would utterly fail to realize reasonable expectations in time of need, unless each boat is furnished with engineers and stokers thoroughly educated by lengthened experience in working them.

I should now like to draw your attention to a statement of the number of torpedo-boats adapted for coast defence, possessed by a few European Governments. This list refers only to those which may be considered as suitable for coast and harbour service in any weather; and I assume a length of 75 feet by a beam of 10 feet to be the minimum dimensions which would render them fit for such service.

	Number of torpedo-boats.	Position of coast.	Approximate extent of coast line in knots.
The Russian Government possesses ..	115	Finland, Baltic, Black Sea.	2,070
The French „ „ ..	50	Channel, Atlantic, Mediterranean, Corsica.	1,640
The Dutch „ „ ..	22	North Sea.	490
The English „ „ ..	19	England, Wales, Scotland, Ireland.	3,740
The Italian „ „ ..	18	Peninsula, Sardinia, Sicily.	2,750
The Austrian „ „ ..	17	Coast of Istria, Dalmatia, and Islands.	800

I annex a statement of the extent of coast line possessed by these various nations. The figures must be taken as approximate only, but relatively, which is all that is necessary for comparison, they are fairly correct, from which it will be seen that—

The Russian Government possesses one boat to 18 miles of coast line.
The Dutch one boat to 22 miles of coast line.
The French „ 33 „ „
The Austrians „ 47 „ „
The Italians „ 153 „ „
The English, comprising only England, Wales, Scotland, and Ireland, one boat to 197 miles of coast line;
And if we include the Colonies at the highest possible estimate, there is one torpedo-boat to 800 miles of coast.

I do not wish it to be implied that I consider countries should be provided with torpedo-boats in direct proportion to the extent of their coast, but simply draw attention to the facts as they stand.

Touching the application of the turbine for the propulsion of torpedo-boats, which I know is greatly favoured by some naval authorities, I beg to draw attention to some very exhaustive experiments with a torpedo-boat propelled in this manner, recently carried out by Messrs. Thornycroft and Co.; these are fully described in a very able paper lately read at the Institute of Civil Engineers by Mr. Barnaby, junr., whose connection with this firm enabled him to give the results with great accuracy, and to this valuable paper I would refer those specially desirous of studying this subject.

Having in view the gradually increasing speeds at which ironclads

are being driven, and the still greater speeds probably to be obtained in the future, it would seem that an increase of speed on the part of the torpedo-boats necessarily follows, so as to always secure an important difference between the two in favour of the latter. To those who are of this opinion I would mention that we see no difficulty in obtaining 24 knots at the measured mile light, or 22 knots fully equipped and ready for action, and we are prepared to contract to give these results.

I will now refer briefly to electricity as a motive power for the propulsion of torpedo-launches.

Torpedo-boats may be divided into two classes: those which have an exceptional speed, and depend mainly for their safety upon their rapidity of movement to elude the enemy; and others, which are only intended to attack during the darkness of night, mist, or when, possibly, a vessel may be completely enveloped in the smoke from its own guns. Under these latter conditions a high speed would be of secondary importance—the success of the attack, and the safety of the boat, probably depending mainly upon its silent movement. For such torpedo-boats, or, more properly speaking, torpedo-launches, in fact, as a substitute for the ordinary steam launch in the Navy, which are mostly fitted out with the spar torpedoes, I believe electricity, even in its present stage of development, would be available.

The diagram C, Plate XVIII, illustrates an electrical launch built last year jointly by the Electrical Power Storage Company, Messrs. Siemens Brothers, and ourselves. This boat was 40 feet in length by 6 feet beam, and we obtained a speed without difficulty of 8 statute miles an hour. The electricity is stored in a number of accumulators which are placed in the bottom of the boat below the water line, and consequently to a great extent protected by their position from the enemy's fire. These accumulators are charged by mechanical means, and as most vessels of war are now provided with dynamo machines for their electric light apparatus, I apprehend there would be no great difficulty or increased complication in charging these cells, which could be done either when the launch is on board the ship or in the water alongside. When once charged it would be available for use at amoment's notice.

Such a boat could easily be provided with spar torpedo gear as shown fitted with Captain M'Evoy's excellent arrangement for firing either by will or contact, or Whitehead's ejecting apparatus. It would be absolutely noiseless, and would have no funnel or fire to betray its whereabouts, consequently it appears to combine many features specially valuable for a successful night attack and to be in some respects superior to steam.

I show on the table a motor such as is used on board these boats, also some storage cells or accumulators, from which it will be seen that the motor by simply completing the circuit of electricity is at once made to revolve; it can also be reversed with equal rapidity, and the entire management of the boat would be under the easy control of one man. I have exhibited this apparatus mainly for the purpose of illustrating how little noise it makes, and I can assure the meeting,

and in this respect I have no doubt I can be confirmed by those gentlemen who were present at the trials of this launch, that the noise produced when working up to its full power and propelling the boat did not to any practical extent exceed that heard in this room.

I would observe that the electricity stored in the accumulators can be made available either for forcing the spar in and out of the water, or for ejecting a Whitehead torpedo. These would simply involve well known mechanical contrivances which could easily be carried out with success.

I wish it to be understood I am not looking forward to electrical launches generally superseding those propelled by steam, I simply submit that, for the particular service I am now referring to, the characteristic features of the electrical system points to its being worthy of consideration.

Admiral Sir GEORGE ELLIOT: I am sure every naval Officer will agree with me as to the immense importance of these seagoing torpedo-vessels. If we read the debates which took place in Parliament last night, we shall see that a consensus of opinion was displayed as to the inadequate strength of our Navy, and the reason assigned for that dangerous state of affairs was that the Treasury was indisposed to increase the Navy Estimates. It is not a political question, because it affects both parties alike. However, that being the case as regards obtaining an additional number of armour-clads, the question of strengthening the fleet by other means becomes more important. From what I read in this paper it would seem that for the sum of one million of money we could build in nine months fifty of these seagoing torpedo-boats. As a naval Officer I would prefer to have twenty-five of these torpedo-boats, costing half a million of money, to having one armour-clad costing the same amount. If we had 100 of these boats and sent say 30 to the Mediterranean and kept the rest at home, 30 to be attached to the Channel Fleet, and 30 for our own coasts, I think we should be better off by far than if we spent two millions of money upon armour-clads. At any rate, we should have to wait four or five years for the armour-clads, and we could get those boats in nine months' time. Looking to our position at present, I trust that what is said on this occasion may reach more powerful ears than mine, and that the Admiralty may come to some decision upon this point. I am not going to detain this meeting very long, because there are so many present who, I know, will be anxious to express their opinions. I shall merely confine my remarks to a few special points. I am quite willing to be accused of having hydraulic propulsion on the brain. Reference has been made by Mr. Yarrow to the building of two torpedo-boats lately by Messrs. Thornycroft, which was considered in the light of a competitive trial between the hydraulic and screw propellers; and, in fact, we were told that the Admiralty had decided to make a light draught of water trial of the hydraulic propeller, and what was the result? The hydraulic boat drew 2 feet 6 inches of water, but Mr. Thornycroft's screw boat could not be moved about except in 6 feet of water. I say that is no competitive test whatever. I wrote to Mr. Thornycroft to ask what the speed of his boat would have been if he had been confined to 2 feet 6 inches, but I did not get any answer. In the first place I am quite confident that he took the utmost pains to get the greatest speed that he could with the hydraulic propeller, but I do not agree with him in the mode of applying that propeller, and I am sorry to say in every experiment that has been made of this mode of propulsion the engineer has adopted some new idea of his own instead of building upon the old lines. This idea of hydraulic propulsion is now half a century old, and we had reached a certain amount of speed in that very bad model of ship the "Waterwitch." So far as the propeller was concerned, it was acknowledged to be a great success by the Admiralty, and I trust that in future any engineer who should endeavour to progress with that mode of propulsion will not depart from the old lines, but will adopt the turbine as it was placed in the "Waterwitch," and not begin

with some new idea altogether. There is another remark of Mr. Yarrow's with regard to torpedo-boats, where he says that there should be two classes of torpedo-boats. I would rather say there should be three or four. In war service I think it will be found that wherever torpedo-boats are going to attack in-shore, every effort will be made to foul their screws. When I was at Portsmouth I recollect a net being made expressly for the purpose, which was laid out and anchored; attached to this net were ropes floated with corks on purpose to foul the screw, and it was found that the screw was fouled most readily. I say therefore that these screw torpedo-boats would be fouled in that way in in-shore operations quite easily. And then another thing, the light draught of water there again might be very essential. Cruizing off shoals or bars with torpedo-boats lying in-shore, it is of great importance that you should have light draught. Therefore, for that purpose a class of torpedo-boat propelled by one hydraulic propeller, which could never be fouled by any means, would pass over any obstructions, and with a light draught of water would be a very useful arm of the Service. I would also notice a remark about driving the boat by electricity. If Mr. Yarrow can carry out that system in the lifeboats round our coast, I think it would be more applicable there than anywhere. Those boats are always used in stormy weather, when the oars lose a great deal of their power, and a motive power of that kind attached to them would be most useful. The reason it has never been yet carried out has been that the weight of the steam-engine is too great for them, but I do not know what the weights of the apparatus in that boat would be.

Mr. YARROW: The apparatus comprising the accumulators and dynamo weighed precisely the same as an engine and boiler would have done if the boat had been propelled by steam. The upshot of it was that the electrically propelled boat went a knot and a half slower that it would have done with a steam-engine of the same weight.

Admiral BOYS: Does the weight include the coals?

Mr. YARROW: Yes; *i.e.*, coals sufficient for a run of six hours, giving an equal duration of run in both cases.

Sir GEORGE ELLIOT: Then I am afraid the only advantage obtained would be that the fires would not be put out. That, of course, would be a very great advantage, because I believe that the great objection to applying motive power to lifeboats has been the difficulty of keeping the fires alight. Therefore, although it is the same weight, you have that very great advantage. I believe the Lifeboat Institution are most anxious to see some motive power, if possible, applied to their boats, because it need not do away with the oars, but might be a supplement to them. Not being able to carry a sufficient amount of electrical power to last a long time, the oars might be used in the ordinary way, and this means of moving the boat would only be used on an emergency. I shall be very glad to find if there is any Officer here who will back me up in my opinion as to the value of these sea-going torpedo-boats attached to a fleet.

Captain CURTIS, R.N.: Looking at these vessels, both Mr. Thornycroft's and Mr. Yarrow's boats appear to draw a great deal more water by the stern than at the bow. That would give them greater resistance in turning and would not facilitate that operation; the long heel and depth of keel give so much resistance. It is the stern that forms the outer circumference in turning. I have studied the "Northern Shark" in the British Museum, and it is about the proportions you would give to that launch; that is, 6·8 feet length to its 4·4 feet beam. With respect to the transport of these torpedo-boats, when the Canadian Pacific line is opened, we shall be able to transport our boats within a week from the Canadian shore to the Pacific Ocean; and I think that is a very great point. Then, as Sir George Elliot has just said with respect to putting out the fires, you have an arrangement to prevent the fires being put out.[1] But I would like to ask by your forced draught whether you do not force the raw fuel up the chimney, and also force carbonic oxide up the chimney, in lieu of carbonic acid, if the combustion was efficient? If you had your forced draught over the furnace and

[1] That can be adapted to a steam-lifeboat.

burned with a downward pressure you would consume your fuel, and your smoke, and you would be giving off carbonic acid with more perfect combustion and economy of fuel. I looked upon Mr. Froude's experiment as a continuation of Colonel Beaufoy's, with this addition, that he is using a screw for propulsion, with additions relative to stability. Professor Froude said the loss of the screw was about 45 per cent. or more, that is, there is a loss in friction in other ways. The late Robert Griffiths, so well known in this Institution, three years ago invented a shield, and he said that shield would prevent a screw from fouling, and would give 6 to 8 per cent. more speed with 25 per cent. less power. But it is like the hydraulic; it cannot get anyone to appreciate its application. It is an immense saving, and anyone who looks into the reports of the Society of Engineers will find that a discussion took place on this hydraulic propulsion two months ago. The screw placed as I stated, two-thirds of its diameter from the stern-post gives 8 per cent. more speed, otherwise the screw is acting antagonistic to ship, trying to draw the water away from the vessel. I think we are very much indebted to Mr. Yarrow for his lecture, and I am sure that the models that we see here may be called works of art. I think some of the members present will recollect my saying some four years ago about that we should not be ramming one another, as some advocated, because when two vessels came within 30 yards of each other there would be a means of expelling torpedoes by steam or forced air—impulse torpedoes in fact—that was the remark I made. I do not give myself credit for introducing them, for no doubt other people had the same idea; but, nevertheless, before I made that remark, there were no such things as impulse torpedoes—at least not in practice.

Admiral Boys: May I be permitted to ask Mr. Yarrow one or two practical questions? I am sorry I had not the opportunity of reading the lecture before it was delivered, because when a lecture of this sort comes before one suddenly, it is somewhat difficult for most naval Officers, who are not accustomed to debating, to discuss such a subject properly. I should like to ask Mr. Yarrow if he could give us the weight of the Russian boats that went by rail from the Baltic to the Black Sea. In the majority of Mr. Yarrow's models before us the arrangement is fixed for firing torpedoes from the bow right ahead, with the exception of the Admiralty boat, where there is a revolving gun or ejector to fire a torpedo in any direction. I wish to point out that it is an undoubted and immense advantage that a torpedo-boat should be able to discharge her torpedo on the broadside as well as ahead. Those boats that fire torpedoes in the line of the keel only must be actually end-on at the time they are discharged. They must check their speed, they must make a circle before they can retire, and consequently will be so much longer under the fire of the enemy's rifles and machine-guns; whereas with the revolving torpedo-gun, a torpedo-boat could rush past at any distance from the ship, perhaps the closer the better, and discharge a torpedo with positive certainty of hitting. None can go on a torpedo expedition without running immense risk. It is a sort of forlorn hope, but still the risk would be much reduced if the attack could be carried out in the way described. I should like, therefore, to ask Mr. Yarrow if he has made arrangements for firing torpedoes generally on the broadside. Another point I see in Mr. Yarrow's boats is that all his screws appear to be abaft the rudder. Is that adopted as a principle? It seems to me that the rudder should be abaft the screw, so that the water thrown from the screw can act upon the rudder. It increases the manœuvring power of the boat immensely. I have turned a torpedo-boat in her own length by simply going ahead and astern alternately, with the screw before the rudder. I believe it is the fact that some slight additional speed is gained by placing the screw abaft, but in my opinion it is not counterbalanced by the loss in turning power. With regard to the training of Officers and men, I think that is unquestionable. I have had some little experience in connection with those boats, and I have seen smart young Officers, when they have been put in charge of one of these long torpedo-boats for the first time, in considerable difficulty. I recollect one case especially, in a narrow channel, the boat getting broadside-on to a tideway, and across the moorings of a vessel, before the Officer knew where he was. In the same way with the engineers. It is absolutely necessary that the engineers who are to work the

engines, as well as the Officers in command, should be thoroughly practised in manœuvring these boats; and it is no more right to send an Officer on an expedition with a torpedo-boat, who has never been in charge of one before, than it would be to place an Admiral in charge of a fleet who had never commanded a ship. With regard to the electrical motor and the turbine, I think those who have had experience will have observed at night that the most striking object, and the object quickest discovered by the electric light, is escaped steam, and that we have not yet any means of preventing steam issuing from any boat propelled by it. The first thing that you discover when you are searching for torpedo-boats at night—no matter what colour they are painted, white, black, or any other colour—the first thing you see is the steam; and therefore one of the main objects to be obtained in torpedo warfare is to propel by some other means, or to discharge the steam so as not to make it a prominent mark for the electric light to dwell upon. Another remarkable point not generally known is that when these boats are going so very fast through the water, a small projectile may pass through the boat, and the water will not come in. I have known moderate sized bullets to be fired through the bottom of a torpedo-boat going at full speed, and the water did not enter at all until she slackened her speed. That gives a torpedo-boat that can discharge her torpedo while going at high speed another chance of escape, even if riddled by small bullets. In reference to electric propulsion, Mr. Yarrow has here a series of accumulators; can he tell us how long it takes to charge these accumulators with sufficient electricity for a specified run? It is, of course, a disadvantage for a boat to lay by continually for a certain time, and my impression is it takes as long to prepare the accumulators as to make the run. That is, if you want a six hours' run, you want six hours to charge your accumulators. Admiral Elliot referred to the great advantage of very light draught of water for torpedo-boats. No doubt it is an advantage.

Sir GEORGE ELLIOT: I said instead of two classes I would have three or four. I referred to one class for light draught of water, and that class to have the turbine.

Admiral BOYS: If we can get the same speed with a 2 feet 6 inch draught of water, of course I would rather have that than 6 feet; but I do not think any torpedo operations will be carried on in 3 feet of water; however, that is merely an opinion. Then with regard to torpedo obstruction, no doubt nets are a source of difficulty, but screws are to be protected even from nets, and we have had instances in our Service of torpedo-boats, with spars properly arranged underneath their bottoms, that have actually jumped over floating obstructions, such as baulks of timber, and got over to the other side uninjured. Mr. Yarrow will perhaps reply to these questions, and I must acknowledge to have heard an excellent paper from him.

Mr. WELLS: May I ask Mr. Yarrow if I am to understand that we only possess nineteen torpedo-boats, or does that list refer to first-class boats only?

Mr. YARROW: To first-class torpedo-boats, suitable for going out to sea in any weather.

Captain CROZIER: I should like to take exception to one of Sir George Elliot's remarks. He said that the "Waterwitch" was acknowledged by the Admiralty to be a great success. I had the command of the "Viper" in the trials against the "Waterwitch," and supposing the "Waterwitch" were the success that the gallant Admiral speaks of, how is it that no other vessel has been built on the same plan?

The CHAIRMAN: I think that is hardly a question that we can discuss. What we have to consider is the subject of torpedo-boats.

Admiral SELWYN: I do not think I could add anything to the eloquence of the facts which Mr. Yarrow has so eloquently put before us. That a first-class maritime Power—a Power which depends for its existence almost entirely on its possessing maritime supremacy—should be in the position shown in the table, is simply astounding and disgraceful, and ought not to be allowed to continue. If it does continue, it will not be the Navy that will be responsible for any catastrophe. With regard to the question that Mr. Yarrow has put before us as to the size of torpedo-boats generally, and their increased efficiency, there is always a tendency, of course, to make a torpedo-boat at last into an ironclad, and a sea-going vessel to go across the

Atlantic. But the question is, can we assign a limit to the functions of the torpedo-boat? If it is to possess all these magnificent qualities at so small an expense, I have no doubt the question will arise, of what great use are the ironclad navies if they can be encountered and defeated by a superior sort of torpedo-vessel, which can put to sea and keep the sea equally with themselves? It is quite clear their time of usefulness would be nearly expired. But our fleet has been in the past and will be in the future not alone useful during the few years of war. It has a utility entirely independent of its offensive qualities during the long periods of peace which come between the periods of war. And, therefore, although perhaps it would excite a certain amount of jealousy in some minds, if it were fancied that engineers and torpedo-boats were going to beat the British Navy out of existence, yet, I think, as long as that question of the difference of capabilities is acknowledged and understood, we naval Officers need not be jealous at all, and we ought to devote our whole attention to at least equalling all that any foreign Power, or any two or three foreign Powers, can bring against us in this shape. It has been said that this is a question of money—that if the House of Commons will only vote the money, the Admiralty will be delighted to build any number of torpedo or other boats. That, again, is a question of mistaken ideas of economy. If our Government are allowed to bring forward as a fact that which is very far from being admitted, that the expenditure of a nation approaches in character to the expenditure of an individual, and that every farthing that goes out of the national pockets is one farthing lost, so long we shall be deficient in all these necessary and wise expenditures, and the public will give credit to the Government for a parsimony which is not economy. Everything done in this way is not economy but parsimony, which is the worst economy possible. We ought to be at the head of all other nations in maritime power, even if they were combined, and shall it be said that the arrow which is likely to wound us is winged from the unfortunate geese who have been green enough to give their ideas—the feathers with which they might have flown—to the English Government in a patriotic spirit, and have been obliged to go, after being refused any sanction at home, to witness the result of their adoption by foreign Governments? That is a scandalous state of things, and ought to be protested against strongly by the profession who are charged with the defence of this country. With regard to the question of torpedo-guns, I do not think Mr. Yarrow shows an enormous improvement over the old system, which reduces the immediate firing power to two torpedoes actually in the tubes until others can be put in. Seconds, not minutes, will be of value when such an attack is made, there is no doubt about it; and the power of firing four torpedoes quadruples the chances of hitting your object and effecting that loss to the enemy for which the torpedoes are put afloat. I think that the weights carried, of fuel especially, may be very seriously diminished with advantage. I should be sorry to see any idea of armour-clad torpedo-boats. I think the essence of a torpedo-boat is that it should be light and strong. Strong, because recent examples have convinced me that in the strength of the vessel lies the greater portion of the speed; that the mid-ship section is not in it; that the breadth of beam is not in it; and that what is in it, and remarkably in it, is the rigidity of structure, as compared with liability to compression or vibration. This has been very remarkably brought forward by the late Mr. Scott Russell. He shows in his great work a yacht, built by White, of Cowes, in which the longitudinal strength was made the principal feature. She attained a speed of 9 knots with 35 nominal horse-power, which gave her a coefficient of about 1,800, that is a very remarkable thing. Attention has not been sufficiently drawn to it, but recently we have been obliged to look at it again, for the "Iris" with her 7,000 horse-power does not do quite so well as her sister ship the "Phaeton" with 5,000. That is owing to the fact of the "Phaeton" having a steel under-water deck, which the "Iris" did not possess. The difference of the 2,000 horse-power taken away was put into the steel armoured under-water deck, and this constituted a longitudinal rigidity, which means that "the tail no longer waggles the dog." I think that the question of boats, like the Brazilian torpedo, crossing the ocean under sail ought to be made a very valuable feature of our torpedo-boats. We cannot expect even so much as other nations who have adopted liquid fuel to carry a large supply of fuel in our small boats, or even in large vessels, and sailing power enables the Officer in

command to use his steam power when he requires it, with confidence in his staying power. It is a most valuable feature, and it can be introduced without materially detracting from the speed or other qualities of the vessel. Had we the sail, I think we should at least be able to see the Officers and crews of torpedo-boats practised in making long runs under sail and short ones under steam in trying their torpedoes. I am afraid Mr. Yarrow is far too sanguine in expecting that we shall have anything approaching to what he has described as existing in Austria. That, again, is wrong —a question of mistaken economy. All that I can add to this paper is, to reassure Mr. Yarrow on the question of confining men in stokeholes. I have recently seen that, on the Caspian, steamers are running in large numbers on the principle, which I so long advocated, of using liquid fuel. The engineer lights his fires on leaving his port, and never looks at them again until he re-enters his port, and he has no stoker on board of any sort or description; that is a remarkable fact. Under those circumstances, he finds one ton of liquid fuel equals two tons of coal. I am absolutely certain that 46 lbs. of water can be evaporated by every pound of liquid fuel driven with steam into any boiler, and that the change from the existing boiler furnaces to that system will not involve a change greater than any engineer on board the ship can make in five hours. When he likes to return to coal again, because he does not like liquid fuel, he can do that also. I do not think there will be much objection to that, and this will add a value to our torpedo-boats, at least, I hope, after we have seen the Russians fitting, as they are now doing, their torpedo-boats and their whole Black Sea fleet with it, perhaps we shall arrive at the conclusion that it is time to begin with ours. With regard to the hydraulic propeller, I confess I am proud to be able to follow and confirm Sir George Elliot in every word he said. The paper read before the Civil Engineers the other day may have been very able; all I can say is, that it proceeded on utterly false assumptions from the beginning, that it ended by utterly false conclusions, and was supported by a table which even to a tyro in mathematics was one of the most extraordinary instances of the utter want of value of mathematical calculations in hands that do not understand them that I ever saw. That table actually stated that, when the push on the boat was ten times as much as it had been before, the boat would go with the same speed. The advocates of the hydraulic propeller are satisfied that the experiment has been a very great success, in so far as it shows that there is no limit to the speed other than the limit of the revolutions chosen to be given to the engine. I have nothing further to add, except that I hope that our Government may at last appreciate the work that is being done for foreign Governments, and may take the right steps in the matter.

Admiral RYDER: I should like to ask Mr. Yarrow if he will tell us, when he replies, how many torpedoes it is proposed to put in these large sea-going torpedo-boats. The small ones never carry more than two. It is an important thing to know how many it is proposed to put in the large boats. Perhaps he will tell us whether, in his experience, the difficulties arising from the vibration of the compasses in a seaway have been overcome. In my experience, when Commander-in-Chief at Portsmouth, the "Lightning," a large torpedo-boat, went round to be altered by Mr. Thornycroft, and when she came back again, the Lieutenant in command reported to me that when she was driven above 8 knots, the Admiralty compasses were perfectly useless, and that having been overtaken by a fog he found, when the fog lifted, that his compasses had so far deceived him in his attempt to estimate the right course that he had actually turned round, and was going in the opposite direction up Channel. That is a difficulty which must be got over. We can't afford, in a torpedo-boat, to go under 8 when making passages, or to stop frequently to steady the compasses. Sir William Thomson, the great authority on compass matters, came down to Portsmouth to investigate this, and when I was there he had not seen his way to get over it. It is a practical difficulty which ought to be met. I do not see any allusion made to any small boats belonging to these torpedo-boats. Perhaps Mr. Yarrow will tell us whether they carry any boat at all; whether the large vessel, 100 feet long, or the smaller torpedo-boat, carries any boat. We found, when I went to Portsmouth, that there was no small boat fitted to either the large or small torpedo-boats; a remarkable oversight. I called in Mr. Berthon's aid, and one of his ingenious canvas boats

was made (viz., two boats, each 6 feet long, which were secured together stem to stern), 12 feet long. These boats were ordered in large numbers by the French Government, and were towed, without risk, astern of the torpedo-boat at even 12 knots speed. I went to Portsmouth the other day to take a run in the new turbine torpedo-boat, built by Thornycroft, No. 72, I think, but familiarly called the "Squirt," and I asked where their small canvas duplex boat was, but they had not been supplied with such a thing. It is a very important question, for the torpedo-boats are of steel, and dare not lie alongside a pier, and as Mr. Yarrow gets so many orders for these boats I am rather surprised that he has not provided for giving them a small boat. Perhaps he will take that matter into consideration. They have the small boats in all the Mediterranean torpedo-boats, and they attach the greatest importance to them. When collapsed they stow under hatches on each side the cabin; the canvas is doubled all over, with an air space; they can be got up and launched on the towline in two minutes. I attended the lecture that Admiral Selwyn alluded to (delivered by Mr. Burnaby at the Engineers' Institute), and listened to it with great interest. I took some part in the discussion, having watched the fall of the turbine principle since it was applied in the "Waterwitch." I had had the advantage of making a run in this new turbine boat a few days ago. I went out to Spithead in her. Her speed was 12 knots an hour; that of course is no great speed compared with what you get out of the large screw torpedo-boats. What struck me was that Mr. Thornycroft had put the orifices a considerable distance above the water, giving a great deal more "work" in lifting the water an unnecessary height. The noise made by this ejection of the water was so great that you could not hear any order given on board, and be it remembered that it has been proved that discharging the water under water in no way diminishes the effect. If you wanted in the "Squirt" to approach an enemy's ship or harbour on a calm night, this erroneous fitting would have betrayed your presence an hour before you got there, owing to this intolerable noise made owing to this unnecessary position of the orifices above the water. In fact, it seemed to me that if it had been wished—which of course was not the case—to discredit the turbine principle as applied to ships altogether, it could not have been better managed than it has been in the "Squirt." That was my impression. The boat was made absolutely useless for the purposes of surprise, owing to the height at which the orifices had been put; moreover, according to the Officer in charge, she must always go at full speed or stop. I do not know whether Mr. Yarrow has turned his attention at all to the turbine principle. I, for torpedo-boats, wish the Admiralty would invite the various makers of torpedo-boats to send in designs for a turbine torpedo-boat to go 20 knots. I have no doubt Mr. Yarrow's ingenuity would lead him to undertake the task if a reasonable reward was offered, say 10,000*l.* (an insignificant sum). If the Admiralty care to give the turbine principle its full chance of success which it ought to have after the remarkable equality of speed in the trial of the "Waterwitch" with her two screw competitors, this invitation would enable them to do so. The impossibility of fouling the turbine; the ease with which it passes gravel through the engine, sucked in through the bottom; the suddenness with which a turbine fitted vessel can be stopped; the handiness of the vessel, as it has turning power independent of the rudder; the power of ramming with the stern, which a screw vessel dare not attempt, this qualification alone might decide the result of a fleet action; the power of using the engine to pump out water in large quantities that may have entered through shot-holes, all point out the turbine as having qualities eminently fitting it for the motor of the future as regards men-of-war. The only practical question is, "Granted that there is, *cæteris paribus*, a loss of speed, how many extra pounds of first cost of engine and boiler, how many extra pounds of coal per mile, are these extra qualifications worth?"

Admiral R. V. HAMILTON: I should like to ask Mr. Yarrow how many torpedo-boats he has made for the English Government and how many for foreign Governments. I am sure that we must all feel that as long as we possess such eminent civil engineers as Mr. Yarrow, who can do all this work for us, although we know perfectly well at the beginning of every war we shall be behindhand, we shall very soon be able to make up for lost time. It is a great credit to this country, I

am sure, to find that foreign Governments—German, Austrian, and Russian—all come to us for their torpedo-boats. Allusion has been made to the fouling of screws. Now, I have studied the annals of the American Civil War, and it is a most extraordinary fact that although that war was principally on rivers, there was not a single vessel in the American Navy disabled by the screw being stopped through fouling.[1] There is no doubt of the very great advantages, as Admiral Boys points out, of having our men most thoroughly trained in torpedo work, and I cannot give a better illustration of it than this, that when I was going out in the "Lightning" with Thornycroft's people on a very hot day in August when there was no wind, they were all in a fright lest the two torpedoes on deck should explode from the heat of the sun. They came to me about it. I said, "Well, you have all these skilled torpedo people on board, they have not the slightest fear about it, and therefore I have none." While on the measured mile, there was an accident to the engine. Down rushed the Thornycroft people; they were right enough then; they knew what they were about, but all we on deck were in a fright, not knowing what the escape of steam meant. I am sure that shows the necessity of training. Other nations are looking ahead at the chance of a war in which they must be opposed to England, and they have taken measures accordingly. I can only wish we were doing as much in the same direction.

Mr. W. H. WHITE: I wish simply to speak very briefly as a naval architect, and as one who has paid considerable attention to the questions of steam propulsion. In these torpedo-vessels we have no doubt the pioneers of future navigation at higher speeds than have ever yet been attained. But those who have studied the matter carefully, including Mr. Yarrow and Mr. Thornycroft, know perfectly well that it must be a very great step from the torpedo-boat to the full-sized ship with anything like corresponding speeds, and I think I may venture to say that neither Mr. Yarrow nor Mr. Thornycroft look for future advance to that extreme rigidity of structure which Admiral Selwyn considers so very valuable. If that doctrine were pushed to its legitimate consequence, then a solid ship, I think, would be the one to attain the highest speed. As a matter of fact, in torpedo-boats which are so remarkable for their speed the construction is remarkable for its lightness, and the facts that we have heard about their vibration all point to an absence of that extreme rigidity which Admiral Selwyn so much admires. With reference to the "Iris" and the "Leander" class, although I am no longer connected with the Admiralty, I am perfectly acquainted with the designs. The performance of the "Iris" was for the time a remarkable success. If in the design of the "Leander" class we had not benefited—I am speaking as having had to do with the design at the Admiralty—by our experience in the "Iris" we should not have been worthy of the positions we filled. As a matter of fact the "Leander" class owe their superiority in speed to improvements in connection with their propelling apparatus and in connection with the arrangements of the outlying parts of the ships—shaft-tubes, struts, &c. They are identical in form. The existence of the protective deck in the midship part has nothing whatever to do with the assumed greater rigidity of the stern, since there is no protective deck at the stern; and I think those who know all the facts will say that I am not misstating the case when I put down the undoubted improvements to improvements in the propelling apparatus, the screws, and the arrangement of minor features of construction of the after part. I would like to add that I think it a great honour to this country that two such firms as Thornycroft's and Yarrow's should have kept the lead throughout as they have done in the construction of this type of vessel. I sincerely hope that they will continue to hold that lead, for there is no doubt about it that, although our Navy may not have as many first-class torpedo-boats as other navies, yet it must be an immense advantage to have in this country establishments which are

[1] In May, 1862, in Albemarle Sound, the "Albemarle," a Confederate ironclad, was attacked by eight wooden Northern vessels, armed with 100-pr. rifled guns and a 9-inch Dahlgren gun, and possessing much greater speed than the ram. Two vessels were specially told off to foul the ram's screw with a large seine, but did not succeed, and the ram got the best of the action.

unrivalled in their powers of production. I sincerely hope that we may see our torpedo flotilla increase. I think that those who have studied the matter will agree that from torpedo-boats we must go to torpedo-cruizers of about equal speed. The Admiralty, as is well known, have already ordered a torpedo-cruizer, the "Scout," which is a very special kind of vessel, though inferior in speed to first-class torpedo-boats. It is to go 16 knots. But in that vessel there are the qualities of handiness and of sea-keeping; she is a thoroughly "self-supporting" vessel, and I think the first example in this Navy of a type of vessel of which we shall hear more hereafter.

Captain CURTIS: Would Mr. White be kind enough to say whether that propeller was two-thirds of its diameter from the stern-post or further away from the stern-post than the unsuccessful vessel which was of 7,500 horse-power?

Mr. WHITE: I may say at once that no suggestion of Mr. Griffiths, to my knowledge, was in any way made use of for the arrangement of the propellers of the "Leander" class.

The CHAIRMAN: If I may be allowed, I should like to make a few remarks on this most interesting paper. In the first page I find Mr. Yarrow says that the Russians were the first who started the torpedo-boat principle. In this country we were a year later—we very often are a year or two behind other nations in making improvements for modern warfare. Going on a little further I find that the Russians at this moment have a vessel called the "Batoum" described as an ocean-going torpedo-vessel. Whereas we have none actually ready, the Admiralty have laid down a vessel of the "Scout" class which I think is a very excellent idea. For my own part, and I believe naval Officers agree with me very generally in thinking that it would be better to have some six or eight vessels of the "Scout" class than one large torpedo-vessel of 1,700 tons, as is proposed to be built, that is to say, to have several vessels of from 500 to 800 tons, rather than one or two of a much larger description. Mr. Yarrow remarks that collisions would become in time of warfare not an unnatural way to attack an enemy's torpedo-boats. I do not quite agree with him there. I think every torpedo-boat should be fitted with a machine-gun to defend itself. You must meet likes with likes. If torpedo-boats attack a vessel, the vessel must get out her boats to defend herself against the torpedo-boats attacking her. It is morally impossible for a vessel to repel a torpedo attack without using her boats. She may try, but if four boats attack her, commanded by determined men, and presenting so small a target as they do, this added to the small arc of radius that there is on board a man-of-war to get the sights on with machine-guns, is all in favour of the torpedo-boat, whereas if you attack torpedo-boats with torpedo-boats you are on a much more level platform, and the chances are that you will do as well in defence as the enemy in attack. Mr. Yarrow says the French boat has less vibration when under weigh than the English boat. I must ask him whether he will tell us if these boats are similar in speed and capability; if so, it is a very important point, because this vibration, as Admiral Ryder told us just now, is a most important matter in a sea-going vessel. If a Captain of a vessel cannot trust his compass, he does not know where he will go; the compass is immensely affected by vibration. Mr. Yarrow also remarks that it would be a very important point if there could be more torpedoes in a boat. He says that he thinks the greatest number of torpedoes should be ready, available for discharge without a moment's delay. I most entirely agree with him there. We should be able to get off as many rounds, if I may describe it so, as possible. The mere fact of being able to fire three or four torpedoes when you are in a position to get them off must be of immense consequence. As to the question of armour-plating the torpedo-boat, I do not agree with Mr. Yarrow for this reason, that every-thing to do with the sea is a compromise. If you want your boat to be very fast, it must be long with small beam; if she is to carry a great weight she must be shorter and with more beam. If you have a gun with which you wish to be continually hitting the enemy you cannot afford to put up armour-plates to shield your men. For my own part I would rather fight a gun that allows the sights to keep continually on and so keep hitting the enemy. In these days, when one shot may win an action, it is better to be in that position than behind a heavy shield where the gun may only get the sights on once in twenty minutes. In the same

way men who are able to keep on hitting the enemy can see what they are at, and they have more confidence, whereas if you have armour up the men cannot see to keep their sights on. You are obliged to work the ship to a great extent, thinking of how your guns bear, instead of looking after your ship as Captain, and letting your guns do their own work. If you armour-plate a vessel you must hamper her in one way. She won't go so fast, or certain compromises must occur which will detract from her great value as a torpedo-boat. Mr. White has made a boat which has a most excellent system of steering. I have been in that boat myself, and it certainly produced very good results. We all agree as to the difference between the results obtained by Messrs. Thornycroft and Yarrow in testing their boats at their own works and those which are obtained when the boats are turned over to us in the Navy. I think the reason is very simple. We say sometimes, "Produce a boat of such and such speed, and so much weight, to carry so much coal and so many torpedoes." When we take the boat to the dockyard we suddenly find a new invention, and put the boat under totally different conditions. We may bring it down an inch in the water, and any seaman knows that the slightest alteration in trim or in draught of water will entirely alter the trial even of a big ship as far as her steaming capabilities go. How much more will that occur with a very delicate machine like a torpedo-boat! As to the training of torpedo-boats' crews, nothing can be more important. As far as England is concerned, we hardly take any steps in the matter at all. There ought, I think, to be a regular torpedo class in the Navy for Officers and men who shall be continually at actual work in the torpedo-boats. I know, as far as I myself am concerned, and I am not a very nervous man, the first time I went into a torpedo-boat, I began to calculate how I had left my property. I never was in a more uncomfortable position. It requires the greatest nerve, care, and practice to work these boats as they should be worked to ensure their success if attacking an enemy. That is all I have to say with reference to Mr. Yarrow's paper. I think as far as this country goes we want a very large number of torpedo-boats, not a few, for this simple reason, that we have so many weak points. Our great commercial interests are a very weak point. We ought to have a large number of boats. I do not care whether stored at Portsmouth, or Plymouth, or where, but they should be numbered so that they could be sent off by land to any of our great mercantile harbours directly war breaks out, because they are the cheapest and best method of protecting those harbours against bombardment. There is no question with the present excellent efficiency of the French Navy that they could put us in the most perplexing position by bombarding such a town as Liverpool. There ought to be a number of torpedo men already trained in every one of these big ports, and these torpedo-vessels should be in store and sent out to those ports in the event of war breaking out. Foreign nations have grasped the question of torpedo-boats. We see all the principal nations giving large orders for them. In reality they have more than we have in proportional number, because we have a great deal more to defend. Mr. Yarrow has taken a great deal of trouble to find the relative numbers out. I do not quite agree with his numbers, because I think very many that he has put down for the Russians are useless, but as far as the French go, you see what an enormous proportion there is over and above what the English have got, and they have not half the work for those boats to do that we should have. The Germans last year actually asked for money to build fifty-four of these boats, while as far as our own Estimates go we have done very little. I think that all our coal stations ought to be supplied with two or three, and the Colonies ought to have a great number. Australia has already seen the necessity for them, and has ordered some, and if we come to think what a magnificent defence torpedo-defence must be for England at a very cheap cost, both as to men and money, we must agree that it is a question which deserves the greatest consideration at this moment. It is perfectly extraordinary to me to see the apathy that this country shows towards naval affairs. There is a sort of blind trust and confidence in everything connected with the Navy. I have said continually both in public and in private that the Navy is not in the state which the country confidently believes it is in. It will not be able to do what the country will naturally expect it to be able to do, if war breaks out. As far as we go, we are excellent, but I venture to say that we do not go half far enough. I believe if we

talked to any one of the naval members of the Admiralty, or to any naval Officer, they will say that boats are most important, but it requires money. They all want to keep the Navy in the most efficient state, and are ready to say that we shall always have the money if we want it. Naval Officers are continually saying that we do want the boats, but the money does not come down. Both parties are equally bad, Conservatives and Liberals, and when the day comes I hope they will remember what all of us have said. I do not say that we shall be beaten; we will do our best if we go to the bottom, but we shall have a very hard time of it, and we shall not win success half so easily as the country thinks, because the country will not give us the ships, the torpedo-boats, or the guns that are requisite to make success certain.

Mr. YARROW: Sir George Elliot refers to the fact that the English Government will get 100 sea-going torpedo-boats for a million sterling. He is quite right in that statement; but he is not correct when he states that they might be obtained in nine months. I do not believe that 100 efficient torpedo-boats could be built in England in nine months even if they were ever so urgently wanted. As regards the turbine, I have not had any experience, and therefore abstain from expressing any opinion. The loss of efficiency as compared with the screw has, I believe, been fairly proved to be 50 per cent., therefore the advantages of the turbine over the screw in other respects must be very great to compensate for this enormous loss of power. Captain Curtis proposes to burn the fire downwards instead of upwards, and in this, I think, he has raised a very important question. I believe it is admitted by every one who has studied the subject that, whether in a boiler or in one's grate at home, if it could be successfully carried out to burn the coal downwards, it would be a very desirable thing to do, but the difficulty is a practical one. The weight of the Russian boats carried overland from the Baltic to the Black Sea was about 20 tons. We have never fitted out boats with any kind of revolving torpedo-guns, for the simple reason that we have never been asked to do so. If any Government wished a gun to revolve, we should be pleased to make it do so. As to the position of the screw in relation to the rudder, that is no doubt a very important question. We do not put our screw always outside the rudder, and I do not believe that in a torpedo-boat there is any gain in speed by so doing. No doubt there is a gain in speed in putting the screw outside the rudder in an ordinary vessel, but in a torpedo-boat where the lines are so very fine I do not believe there is any gain whatever. The fact that in the boats I referred to in the early part of the paper, where we obtained an advance of 3 knots, and also in the second-class boats where we obtained 17·27 knots, the rudders were aft of the screw in both cases, tending to confirm my statement. I think, in some cases, the rudder being aft of the screw is actually advantageous to speed. My reason is, that the rudder tends to check the rotary motion the screw gives to the water, and reduces the slip of the propeller—in fact, I am inclined to think if the rudder is very thin in a torpedo-boat, if placed aft of the screw, there is a positive gain rather than otherwise. We place the screw aft of the rudder on account of the facility with which it is got at. If the screw hits anything, the shaft invariably bends outside the post, and consequently it cannot be drawn inwards and must be brought outward. That can be much easier done if the screw is aft of the rudder, and I think that is a very good reason for adopting this plan. The Austrian and the Italian naval authorities both favour that position. Admiral Boys asked how long it takes to charge the accumulators. I am sorry to say it takes 25 per cent. longer to charge them with the minimum waste of power than it does to use them. Of course that is a very great drawback. I am glad that Admiral Selwyn agrees with me that in the large boats there may and ought to be more than two torpedo-tubes; and I was very pleased to find that his Lordship also advocates it. For my own part, I feel very strongly about it, because I think in actual practice the charging of spare torpedoes will occupy valuable time, do it how you may, and at a critical moment will be attended with many difficulties. I suggest that the spare torpedoes might be very advantageously substituted by one additional torpedo-gun with its torpedo ready to fire, the weight remaining the same. There is no difficulty so far as carrying it out is concerned, and I am quite certain there is no practical objection. In fact, when we consider that, in a second class boat of 12 or 13 tons displacement, two torpedoes are carried, it is clearly evident that

there is nothing to prevent three or even four being carried in a boat of from 40 to 60 tons displacement. As regards liquid fuel, I am glad to agree with the gallant Admiral who raises this question. If that were practicable, there would no doubt be a very great reduction of weight; or if the same weight of fuel were carried, I think I may say that the boat would have much longer steaming powers, possibly double. The point is this: In Russia they have practically carried out the burning of liquid fuel, but that has been successfully done where a moderate rate of combustion only is wanted. I think it remains to be shown how it can be done where a rapidity of combustion takes place, unequalled in any case to what is needed in torpedo-boats: there are many practical difficulties in the way. Admiral Ryder asks whether in the English boats there are two torpedo-guns to be placed in the bow, and if two spare torpedoes are to be provided to replace them—four in all—as far as the bow is concerned. That is so; and in addition aft there is a revolving torpedo-gun, and that has got its torpedo and a spare torpedo. As far as the difficulty about compasses is concerned. all I can say is this, that in our eight boats that have been navigated across the Atlantic no reference has been made by the Captains to any difficulties at all.

Admiral RYDER: They were under sail.

Mr. YARROW: We have steamers out at the Mediterranean ports—about a dozen—and I have heard of no difficulty; but what I do know is, that in two that were steamed from London to Pola by the Austrian authorities, special reference is made in the official report to the efficiency of the compasses. As to small boats, you will see by the models that there is one on the deck of each first-class boat, but in the second-class we have none. With regard to the suggestion that the Admiralty should invite tenders for turbine-propelled boats to go 20 knots, I am very much disposed to think that, if they did, they would not get any answers. Admiral Hamilton asks how many torpedo-boats we have constructed for the Government. I may say we have built one first-class and four second-class. I only regret we have not had the honour of supplying more. Foreign Governments have patronized us much more largely than the British. We have built about 40 sea-going boats of the largest class. Lord Charles Beresford asks whether, in comparing the English and French boats, in which I speak of the rigidness of the French boat, and for which statement I am indebted to the Russian authorities, the boats may be said to be practically of the same speed. Mr. Thornycroft's is a little faster than the French one, but consumes more coal. I was very glad to find that his Lordship agrees with me about the three or four torpedo-guns for the large boats. As regards the armour for torpedo-boats, I did not advocate it. I only pointed out what was practicable, and what amount of armour, speed, and size can be combined; but I do not advocate it. As far as training the men for working the boats, I do think it is deserving much more attention than has been given to it, and I am very glad that so many gallant Admirals have taken the same view. We have often heard it stated that the English could build a number of boats very rapidly in case of sudden emergency. That may or may not be true. At any rate, it strikes me, in these days, when wars come upon us rapidly and are over as rapidly, we might find the torpedo-boats were just finished in time to be too late; but as far as training the crews, it would be quite impossible to train men in any time that a reasonable war lasts in these days. Permit me to conclude by thanking you very much for your kind attention to my paper.

The CHAIRMAN: I have much pleasure in returning to Mr. Yarrow a cordial vote of thanks in your name, gentlemen, for his lecture, which I am sure has been most instructive and interesting.

Friday, April 25, 1884.

ADMIRAL THE RIGHT HON. SIR JOHN C. DALRYMPLE HAY, BART., C.B., M.P., &c., &c., Vice-President, in the Chair.

THE MONCRIEFF SYSTEM APPLIED BY HYDROPNEUMATIC GUN-CARRIAGES TO HARBOUR DEFENCES.

By Colonel A. MONCRIEFF, C.B., F.R.S.

SOME attention is now being given to a very important but hitherto practically neglected subject—the defence of our commercial harbours at home, and our coaling stations and strategic harbours abroad. It has been intimated that the Government contemplates asking a vote of two millions for these purposes: it therefore seems a fitting moment to review the subject of coast fortifications and their armament, and to consider in the light of modern requirements which is the best and most effective way of spending the money.

It is needless for me to dilate on the magnitude of the interests involved at our great commercial ports. That was admirably done last month in this theatre by Colonel Sir Charles Nugent.[1] This paper relates to but one detail—although an important one—of the great subject which he handled with so much ability. It is equally needless before such an audience to occupy time in demonstrating the vital importance of defending the coaling stations upon which depends the ability of your fleet to keep the sea.

It has been calculated that at Liverpool there is 400,000,000*l.* worth of property which a hostile fleet could burn and destroy, and if we add the mischief that might be done in the Clyde and the Tyne alone, we shall reach a figure considerably in excess of the National Debt.

In case of war the fleet would have abundance of work without defending our ports, and were that its chief occupation, the fact would remain that no more costly system of defence could be chosen. At many points in our widely scattered possessions great wealth is concentrated in highly valuable sites, and in spite of the utmost vigilance incalculable damage might be done by an active and daring enemy. As for the coaling stations, each one lost would not only be a heavy deduction from our own strength, but a great addition to that of our foes. Modern changes in naval warfare have at once increased their value and added to the risks attending their present defenceless condition.

The supply of garrisons to defend these distant coaling stations will

[1] "Imperial Defence," by Colonel Sir Charles H. Nugent, K.C.B., R.E. *See* Journal, No. CXXV.

be a much greater tax on our resources than the first expense of fortifying and arming them, not only because the yearly expense of the garrison capitalized is greater than that first cost, but from the difficulty in this country of supplying trained men for such a purpose. It would therefore be of first importance by all possible means to design these defences on the system which will give the greatest efficiency with the smallest number of men. Any system which exposed the garrison to the risk of heavy casualties from naval fire would for such positions be particularly inapplicable. To select any system open to such an objection in place of one giving adequate protection to the men would obviously be to disregard both true economy and efficiency.

In my last paper on this subject, read and discussed here on the 15th March, 1875,[1] to which, and to that of 9th June, 1873,[2] this paper is supplementary, I referred shortly to the other elements in harbour defence. On this occasion the method of mounting the artillery is that to which I propose to confine my remarks. The reasonable hopes and expectations that were expressed by me on the last occasion have been so completely disappointed, and that part of the subject in which I am most interested since then so much neglected, that it is with a sense of lost opportunities that I now address you.

I feel, however, that the subject is so important a one to the State and to the tax-payer, that it is my duty to continue the ungrateful task on which I have been so long engaged. There is this difference, however, between the time I lectured here last and the present—that then this country was in advance of others in the application of hydropneumatic Moncrieff gun-carriages, whereas now we are left behind; these carriages are now not only used on land fortifications abroad, but also afloat, working successfully with guns up to the weight of 40 tons.

Professional men do not now advocate the concentration of heavy artillery. The advantages of dispersing and concealing the guns is more generally conceded, while the importance of placing the magazines so as to be quite invulnerable by direct fire is fully appreciated, as well as the value of increased lateral range coupled with protection. I regret, however, that the best means of procuring all these advantages is left in the background here as much, or more so, than it was then, while the responsibility for this rests exclusively on one department of the War Office.

In order to lay down some common ground on which all will agree, and on which the subject can be discussed, I submit that the principle on which commercial harbours can best be defended is that one *which will give the most efficient protection and the greatest offensive power with the smallest garrison.* As a secondary consideration, but still important one, on that system *which is most economical.*

The principle thus defined I think embraces the whole question, and is therefore a safe criterion by which to judge the comparative merits of each system available for *Harbour Defence.*

[1] Journal, No. LXXXI, p. 357, *et seq.*
[2] Journal, No. LXXIV, p. 592, *et seq.*

It is perhaps desirable now to refer shortly to what has been done for the *Attack*—what progress has been made in naval armament—since I last spoke on the subject in this theatre about nine years ago.

1st. Naval artillery, as then predicted, has been greatly increased in power. It is now a question, I believe, whether the magnificent iron casemate and shield batteries, which form the prominent features in our coast defences, are as sufficient for their purpose as when they were constructed—whether they are strong enough to resist the heaviest projectiles now employed in foreign navies without being strengthened by additional thickness of iron and by increased strength of the external walls to protect the magazines. These works are sometimes criticized alone from a modern point of view; in common fairness, however, what Sir Charles Nugent mentioned last month should be kept in view, viz., that at the time some of them were designed a 68-pr. gun of 95 cwt. was the heaviest gun in the Service. But now, for instance, a notice appeared in the "Times" the other day, that the Italian Government had ordered from Krupp forty 121-ton guns.

Perhaps, however, the most important advance that has been made since 1869 is in the development of machine-gun fire from ships. By referring to Captain Lord Charles Beresford's masterly paper, read here on the 15th June, 1883,[1] it will be seen that this formidable method of attack has been carried further in foreign navies than in our own. I quote one pregnant sentence from this paper. "The disproportion between England and France, however, in the machine-gun question is still further increased to England's most dangerous disadvantage by all the French machine-guns throwing shells, whereas the English have no machine-guns except those firing bullets." It is well to note the bearing it has on the question before us. Machine-guns can pour their projectiles in a constant stream on any desired points which are visible from the sea, and men cannot work or even live exposed to this incessant stream of bullets, which range from musketry size up to 6-pr. and even 9-pr. shells. These guns, moreover, are not only carried on the decks, but some are also carried on the tops, so that they can attack low shore batteries with greater command. Wherever there is a definite object to aim at, such as a gun mounted *en barbette*, or the port of a shield or casemate, this stream of bullets may be expected occasionally to reach it correctly, even although directed from a moving platform.

What may be the exact moral and physical effect of this incessant stream of fire on the men, and what the injury it will inflict on the barbette gun-carriages and breech-loading mechanism, it is somewhat difficult to say; but I have no doubt it will be an important element in producing results for the attack—more particularly when machine-gun shell fire is employed.

In any case it would be a great error in providing harbour defences to ignore, or not to provide against, this new and formidable method of attack. Any neglect in this respect is calculated to cause

[1] Journal, No. CXXI, p. 601, *et seq.*

a great waste of life in the defence, and would probably render the guns almost useless, because men cannot act with sufficient coolness, lay guns with deliberation, and aim with the same accuracy, when they are exposed to a stream of bullets or the *débris* of shells, with but slight protection from their effects.

It is very unlikely that the full complement of highly disciplined gunners will always be available to man these batteries, but even the best disciplined men could not be expected to make sufficiently good practice under such circumstances.

Means have been lately devised for giving the men more cover than formerly in barbette batteries, by traversing the guns after each shot to one side, and loading them whilst depressed. This method, which is called *side loading at depression*, has its own advantages and defects. A portion of the gun-carriage and the gun itself is, however, always exposed to view in this as well as in all other barbette batteries, and necessarily also to shot and shell. They thus afford a correct and easy mark for machine-gun fire, the shells from which will search the greater part of the gun emplacements.

Now that it is possible to direct a continuous stream of fire against any visible object, the importance of depriving the enemy of any visible and definite object to aim at is of paramount importance, because by removing any such object, the accuracy of that kind of fire is reduced, and its deadly stream is more likely to be wasted on points where men are not working.

Loading at depression, without traversing, which method is applied to short muzzle-loading guns, gives the men no doubt better cover, but on the other hand, it, as well as side loading at depression, defines the position of the gun, by raising its large breech—its exact position is thus made more prominent while the gun is being loaded.

It may be said that any advantage gained by loading at depression in either method, has been neutralized by the improvements in naval artillery since 1869—especially in machine-guns. So that, so far as barbette batteries are concerned, the question remains very much as it was when Admiral Sir F. W. Grey's Committee reported on the Loan works fifteen years ago, except, perhaps, in one detail, viz., the height at which barbette batteries are admissible. This may have been modified by the practice of using machine-guns on the tops of ships, thus giving them relatively greater command.

As guns mounted on any kind of barbette batteries are exposed, and the gun-carriages and men serving them partially so, they are liable to be silenced by naval fire, both at long and short ranges.

Before naval artillery had nearly reached its present development, barbette batteries were condemned for all important positions near the sea level, otherwise the great iron-plated works would not have been proposed for such positions, and constructed thereon at great expense, and obviously such expense would have been unjustifiable. All barbette batteries which had not a certain height above the sea were considered out of the question, as quite unequal to meet naval attack, even at that time when naval artillery was by no means what it is at present. It is necessary to keep in view the important

fact that the increased range of naval artillery alters the vertical angle at which the attack can be made on shore batteries, and thereby also the conclusions arrived at as to what constituted sufficient command for barbette batteries.

All these considerations, I think, point to this conclusion, viz., that the deliberate abandonment of barbette batteries for important positions on sea faces, at the time the iron-shielded works were constructed in this country, was justifiable and inevitable, and that the reasons for continuing this abandonment, notwithstanding the contrivance of *depressed loading*, are as potent and as conclusive now as they were at that time, if not more so.

I venture to think that the more this matter is investigated the more clearly it will be seen that the above conclusion, first arrived at before the Loan works were designed, is sound and well founded. If so, we may dismiss once and for all the thought that any wise, safe, or true economy is to be got by placing guns in important positions, *en barbette*, for any kind of harbour defence, and that unless these batteries have the proper command to make them comparatively safe, they are likely to be a deception to the uninitiated in time of peace, shambles to their defenders in the time of war, and when most required, unequal to the work for which the batteries are constructed. Let us therefore go on to the other alternatives which are available.

Shield and casemate batteries take the most important place for that purpose in this country. It is on that principle that our most valuable positions at home are defended, and much faith is reposed in the system of which they are the main feature. That system may be said to consist of opposing force to force—in neglecting the exposure of the works to observation, and to direct fire, making them strong enough to resist it, and in massing the heavy guns of the defence. The works representing this principle are magnificent, and will remain monuments of our wealth and of the resources of this country in iron, and in the skill to apply it. They, including iron land turrets, form undoubtedly an alternative, although an expensive one for the artillery defence of the commercial harbours. Two-gun turrets of sufficient strength to resist new guns now cost, I understand, about 45,000*l.* each, without the magazines or foundations.

The remaining alternative, which is the one I advocate, one which I might almost describe as created by myself, is that carried out by means of disappearing carriages, used in the manner I shall proceed shortly to describe.

I cannot do better than use the exact words I employed to describe my system at the Royal Institution of Great Britain on May 7th, 1869. It will at any rate show you that I press no new nor crude idea, and that my views on the general principle involved remain unchanged, after all the experience I have had in applying it:—

"It must be borne in mind that batteries intended to engage ships are obliged to meet an enemy who can move his position to that quarter where he is least exposed, who can continue in motion while he is con-

ducting his attack, and who can seek out the most vulnerable face of the land-work to operate upon.

"In constructing such batteries it is first of all necessary to make them of sufficient strength to resist the guns of ships which are the most powerful that can be made.

"It is next required that these batteries should be constructed in such a manner that they can direct their fire with rapidity and precision in any direction in which the ships can take up their position.

"And lastly, it is required that they should mount guns of sufficient weight and power to be formidable to the heaviest ironclads.

"In former times guns *en barbette* were preferred for this purpose, because they met the two first requirements alluded to; that is to say, that from not being confined by embrasures or ports, they were able freely to follow their floating enemy, whatever position he might take up, naval fire at that time being neither so correct nor so formidable as to make such batteries unserviceable. The case, however, is now completely changed; for not only have guns been improved, but ammunition also; and heavy shells are most destructive. Rear-Admiral Porter, of the United States Navy, in a report on coast defences, says, 'Such guns, *standing so high up*, are just the objects that naval gunners would delight to explode their shrapnel against, and from my experience in naval gunnery, the third shell would kill every man at the gun.'

"Von Scheliha, in his treatise on coast defences, says, 'Guns mounted *en barbette* may always be silenced by an ironclad.'

"This form of battery, therefore, is disposed of.

"We shall now examine the difficulties connected with the other alternatives. Common masonry batteries have been condemned as worse than useless, as they would only make the ship's fire more destructive than if directed against guns *en barbette*.

"Next comes the expensive alternative which has been adopted, viz., iron shields, casemates, and turrets.

"The battery is in the position of a knight who must either expose his vitals to his enemy's lance or put on armour that paralyzes his sword arm.

"There is as much protection in the power of being able to strike as there is in being able to guard.

"As naval actions are likely to be short and decisive, it must have appeared extremely doubtful whether it was worth purchasing increased safety at the expense of losing the attacking power.

"My solution gives a system capable of mounting the heaviest artillery, while it simplifies the vexed question of fortification. It gives protection without the expense of using iron, and free lateral range to the guns without exposure.

"The system is indeed a simple one; it does not require either brute strength or heavy expenditure for its application; nor does it need mighty forges to weld iron walls to protect our guns and gunners; it only calls to our aid the simplest and most docile forces of nature.

"Instead of trying to meet force by force, I make my guns bow to the inevitable conditions which science has imposed; and instead of wasting energy, money, and skill in attempts to raise a buttress against the new artillery, I employ the hitherto destructive force of recoil to lower the gun below the natural surface of the ground, where it can be loaded and worked in security and in comfort; and, at the same time, I have made that destructive force so much my servant that I compel it at my pleasure to raise the gun again into the fighting position whenever it is required.

"The principle on which the carriage is constructed is the first and most important part of the new system, because on it depends the possibility of applying the other parts. This principle may be shortly stated as that of utilizing the force of the recoil in order to lower the whole gun below the level of the crest of the parapet, so that it can be loaded out of sight and out of exposure.

"The second part of the system, viz., the profile of the batteries, is of the highest importance, because, unless it is attended to, great advantages are lost.

"This, unfortunately, makes the system extremely difficult of adaptation to existing works. In order to get the full advantage of it, no exterior slope of parapet should be exposed to the view of the enemy. This prevents him from being able to tell whether the fire be correct or wasted, and affords no means to him of correcting error.

"The battery in fact is masked; so that at some distance, or in dull weather, a moving ship would have considerable difficulty in laying her guns on one battery, and still more difficulty if there were several batteries judiciously placed for the purpose of deceiving the eye.

"It can easily be understood that the slightest error in elevation would either carry the shot harmlessly over the battery or else cause it to ricochet off the glacis or superior slope.

"In fact, when the gun is down, the enemy has nothing to aim at but an undefined horizontal line.

"Up to the present time the new system has only been considered as an improvement, and its value has only been estimated as an adaptation to existing forts, and there are no proposals for applying it *per se*.

"I am extremely anxious to impress on you and on my countrymen that its full value cannot be seen in this manner, and that it suffers injustice by being thus treated. I trust its proper use will be fully discovered before the inevitable lesson is dictated by war, and that it may be applied in works expressly designed for it, and not merely adapted to its use.

"The third part of this system consists in its application to given positions, the disposition of the batteries, and method of working them in concert with or in support of each other.

"If I might be excused for using the paradox, the system for coast defence consists in the absence of any defined system; that is to say, instead of making large regular forts, and forcing surrounding circumstances into harmony with them, every accident of the ground in this case would be seized where available, and small batteries, consisting

of a few guns, or even one powerful gun, laid down so as not to take away the natural aspect of the position.

"These guns would be disposed in such a manner as to retain as much as possible for the defence the advantages of a free lateral range, converging fire, and different amounts of command. In other words, the method consists in placing in position the heaviest and most powerful artillery to the greatest advantage, making that the first consideration, and afterwards protecting the batteries, by separate and distinct arrangements easily devised by Officers on the spot, against assault by any force that ships might land for that purpose.

"The dispositions of defensive batteries such as those I have very imperfectly attempted to describe would not be complete without good arrangements for internal communications, not only by roads, but by telegraph, with a clearly laid down and simple method of working them; that is, not liable easily to go wrong, nor to lead to mistakes, and which would not require very high skill.

"Such arrangements would increase the power of the defence, and indeed would be necessary with the detached system.

"I have accordingly given them some attention, and designed a general plan of laying off the ranges and working the telegraphs, which will make it possible to supply simultaneous information.

"The system I refer to (which has been submitted to the Director-General of Ordnance) would apply to any position, but its particular application would vary in each case."

Pray note that the paper I quote from was read and published fifteen years ago.

To resume,—Broadly speaking, batteries constructed on sea faces must belong to one of three different systems. In this paper I shall continue to designate these as the 1st, 2nd, and 3rd alternative.

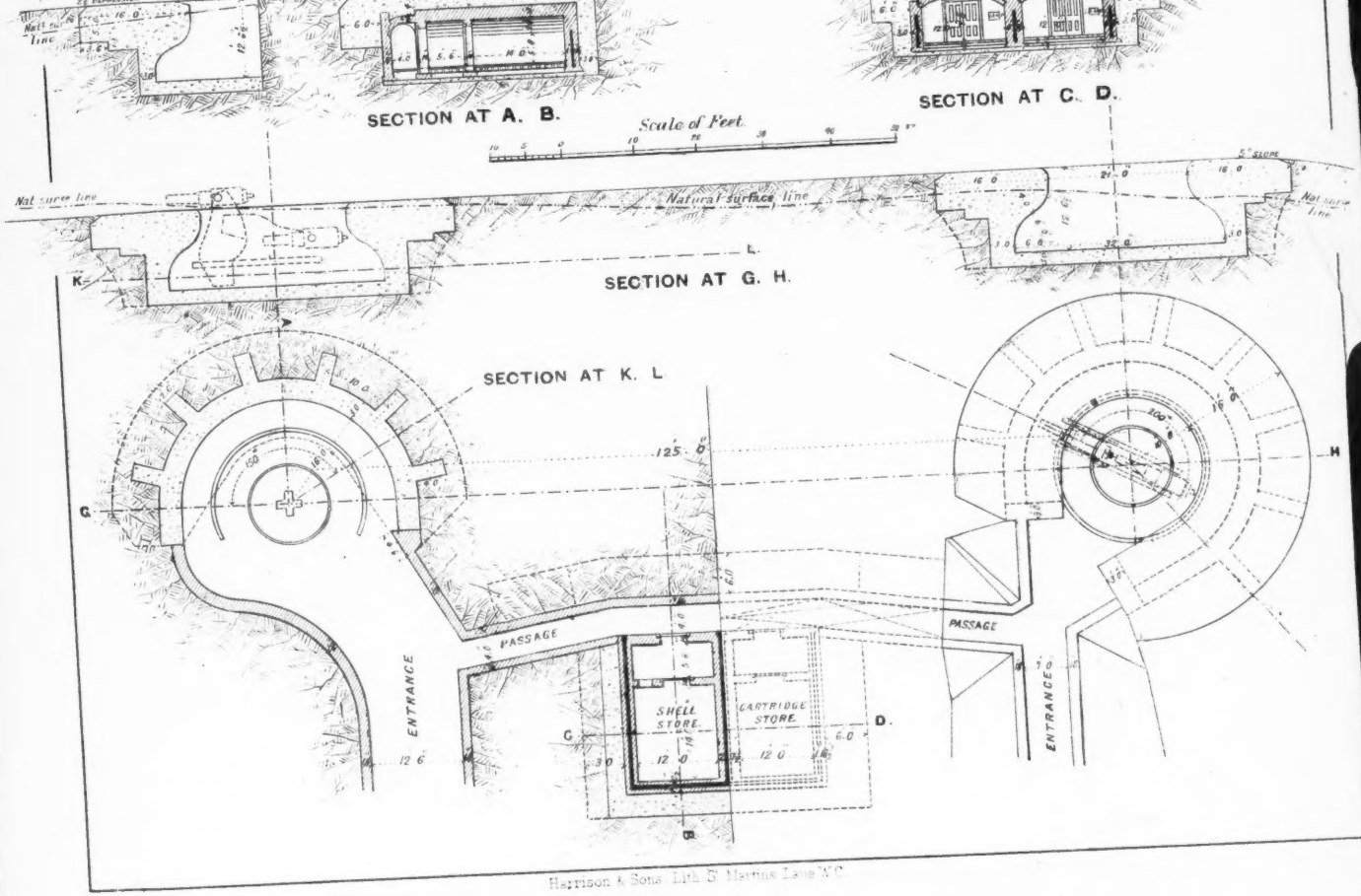
1st. That of barbette, which has been discussed and may now be dismissed.

2nd. Iron-plated works.

3rd. The Moncrieff system, *i.e.*, the one carried out by means of disappearing carriages, and which I designated "protected barbette" the first time that I lectured in this theatre.

To prevent confusion I may here mention that the term "protected barbette" is mine. I contrived the expression as an appropriate name for my system, by which it was for many years well known. Recently, however, the "depressed loaders" appropriated this term for their ingenious contrivance, and gave the name "disappearing principle" to my system. I note the implied compliment, and the laudable desire to arrive at the same result, and humbly accept the title of "disappearing;" still confusion is caused by applying the term "protected barbette" to a different system from the one to which it first belonged, and giving it to one which leaves the gun always entirely exposed to the enemy's fire.

The question at issue which, after all that has passed, has yet to be solved, a question on which a good deal depends, is, which of the three alternative systems ought to be preferred in future harbour defence. To put it otherwise, *which system will give the most efficient*



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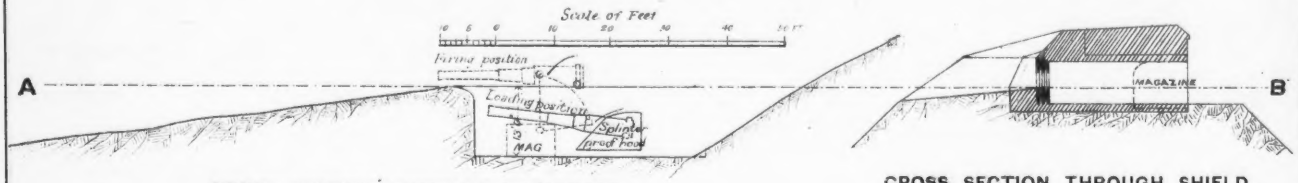
COMPARATIVE VIEW OF SHIELD AND MONCRIEFF EMPLACEMENTS,

WITH THE GUNS PLACED ON THE SAME LINE, AT THE SAME INTERVALS, AND WITH THE SAME COMMAND.
ALSO SHOWING THE POSITION OF THE MAGAZINE IN EACH SYSTEM.



CROSS SECTION THROUGH MONCRIEFF.

CROSS SECTION THROUGH SHIELD.

THE EMPLACEMENTS IN THIS CASE ARE ADAPTED FOR 10" B.L. GUNS OF 27 TONS, FIRING 500 LBS. PROJECTILES AT A M. VELOCITY OF 2,100, AND DESCENDING BY MEANS OF THE RECOIL 9 FEET BELOW FIRING POSITION, ON HYDROPNEUMATIC MONCRIEFF CARRIAGES.

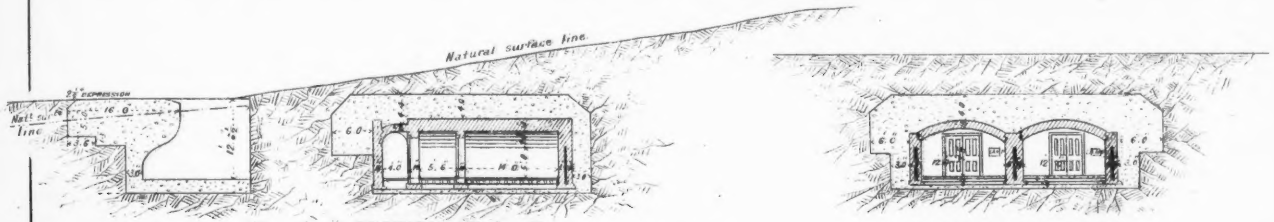
MONCRIEFF BATTERY.

SHIELD BATTERY.

ALL THOSE PARTS ABOVE THE HORIZONTAL LINE A.B., WHICH LINE COINCIDES WITH THE NATURAL SURFACE AT THE GUNS, ARE NECESSARILY EXPOSED TO VIEW, AND ALSO TO DIRECT FIRE. IT WILL BE OBSERVED THAT THOSE PARTS DO NOT EXIST IN THE MONCRIEFF BATTERY, WHICH THEREFORE SUITS THE DISPERSED SYSTEM, AND FULFILS THE CONDITIONS STATED AT PAGE 687.

DRAWING PREPARED BY COL. MONCRIEFF IN 1872 FOR THE COMMITTEE ON MONCRIEFF CARRIAGES.

SHEWING ARRANGEMENTS FOR A BATTERY OF TWO GUNS, WITHIN AN ARMED POSITION ON GROUND FALLING TOWARDS THE SEA, ON THE FRONT AND RIGHT FLANK. THE LEFT GUN HAVING A RANGE OE ABOUT 150° AND THE RIGHT ABOUT 200.° IN THIS CASE THE EMPLACEMENTS ARE ADAPTED FOR 9" 12-TON GUNS ON COUNTERWEIGHT MONCRIEFF CARRIAGES.



SECTION AT A. B.

SECTION AT C. D.

protection and the greatest offensive power to the smallest effective garrison.

I repeat the expression, "which system ought to be *preferred*," or which can best be relied on to give the required results with the greatest advantage and economy? No doubt there are exceptional cases in which local conditions may make a particular system peculiarly applicable, and these cases must be dealt with on their own merits.

Putting aside, however, for the present, exceptional cases specially adapted for any one method, allow me to press for a decision on the main question at issue, to which I shall confine my remarks, and which I conceive to be a deliberate selection of that system which is best adapted for meeting the necessities of harbour defence, especially at the most vital points. Such points as will, on the one hand, be exposed to the most overwhelming cannonade from the ships, and on the other hand give the artillery of the defence the greatest lateral play to its guns, and the greatest opportunity of delivering telling fire within the position. That system which will enable a few gun detachments with comparative safety to themselves to offer the most formidable menace to vessels in attacking, whatever position they may take up. The system in fact which should give its own character to the main features of the defence.

I submit that if a decision be arrived at on this broad and fundamental basis—a decision not qualified by doubt or uncertainty—the designs for protecting coasts and harbours from naval attack could be carried out with a prospect of more satisfactory results than if it is left undecided. Each system requires different handling, and the manner in which the defence of a position will be designed by the engineer and conducted by the artilleryman will consequently be greatly determined by this decision. The price at which it can be efficiently fortified and defended I shall endeavour to show is also largely affected by the same decision.

The three main features of the Moncrieff system (or 3rd alternative) which distinguish it from the iron shielded batteries are these:—

1. With the 3rd alternative, the battery itself and the magazines are absolutely invulnerable by direct fire, however close the ships may approach, or however powerful may be their guns.
2. It presents no definite object to aim at except at the moment the gun is up, and therefore fire cannot be directed on it with the same precision as on the other.
3. The guns have unlimited lateral range.

1. An inspection of the plans (Plate XIX) will show that the position of the magazines in the pierced parapets of shield batteries, which can be breached by direct fire, is not free from danger, and that a port, or the gun in the port, is always open to shot, shell, and machine-gun fire. How far the mantlets are proof against the latter I do not know. The men are therefore, especially from the exposed position of the magazines, by no means so completely protected as they are in a Moncrieff battery. This fact finds expression in the official Report of

a Committee who investigated this point. (See Report, dated 23rd July, 1872.)

2. The importance of having a battery masked while in action does not seem to have been appreciated very highly in this country, judging by the manner in which most Moncrieff carriages have been placed. Notwithstanding this fact, I affirm that whoever neglects this condition, when using disappearing carriages, deliberately throws away the most valuable feature which they possess—a feature that ranks for value quite in the same line as the strength of iron used in shields, although they are produced at great expense. I should almost say this constitutes a condition more valuable than the strength of iron plates, because it not only entirely defeats direct fire, as they can scarcely succeed in doing, but by making it next to impossible to hit the mark, or when hit to do harm, it also discourages and embarrasses the naval gunner in a way that no iron works can do. It gives him no clue whatever to determine whether he is inflicting an injury or wasting his fire.

On this last point the opinion of sailors is particularly valuable.

The 3rd feature of the Moncrieff system is its unlimited lateral range. Now, the unlimited lateral range, or play of the guns, possessed also by iron turrets, but paid for in their cases at an exorbitant price, costs nothing in Moncrieff emplacements. If, therefore, it costs 45,000*l.* in a turret, and is advantageous at that price, it is surely worth something in the other case. This free lateral range, coupled with protection, is indeed a most valuable property. It has its greatest value when the system is properly applied—and it is not properly applied unless full advantage be taken of free lateral range—which has not yet been correctly estimated. I am fully justified in this statement, because the official estimates of its value are based on the adaptations, and not on proper applications. These adaptations preclude the possibility of taking the full advantage of free lateral range; they are indeed mostly positions that were previously arranged for embrasure guns.

It is quite obvious that if a harbour is to be defended there will be sometimes sites which would afford a lateral range frequently four times greater than can be got by firing from any embrasure or port; and that it would be an exceptional case if any gun could not be utilized for at least double the maximum lateral range of an embrasure.

If the selection of the disappearing system or 3rd alternative, based on these obvious advantages, were frankly announced, the Department of the Director of Artillery could not continue their present policy of stopping any extension or illustration of the system by simply preventing a suitable carriage from being tried. It ought, I think, to be distinctly stated here by me, and known by you, that the Department of the Director of Artillery, and they alone, have by this means stopped, and are now stopping, its application. In the interests of economy—not to speak of efficiency—the engineer would, in designing the works and laying down his emplacements, avail himself of disappearing carriages for heavy guns if he had them, especially at

distant coaling stations, where the supply of men was the most serious consideration; and in positions where it was essential to give the men as much protection as possible, because fewer guns would be required, and they would thus be more efficient; but if these carriages are not available for the only heavy guns he can employ for coast defence, he is of course forced to use the 1st and 2nd alternatives.

The minimum estimate of a highly experienced engineer Officer, viz., his Excellency the Baron von Scholl, who made long studies on this subject, and from whom I quoted more fully in my last paper, is, that one half the guns could be dispensed with. He says: "Considering now that the effect is highly dependent on security, I would always say that, for instance, two guns upon your carriages are equal to four guns upon common carriages. This is a very considerable advantage, not only in saving money, but what deserves more attention, in economy of men, who are always the dearest article, and especially when they require such a careful instruction as those who have to work heavy guns."

The words of the Report of the Committee on Moncrieff carriages on the same subject are "one gun mounted on a Moncrieff carriage may do equal work with two or more guns mounted behind shields;" and they also reported "that in their opinion the system will be found particularly well adapted for the defence of the great commercial harbours."

If any value is to be attached to these formal and official statements, it follows that a large decrease in the garrisons, corresponding to the decrease in guns and in batteries, could be obtained by the proper employment of the disappearing system or 3rd alternative. In this country, at any rate, this is no matter to be neglected, for the supply of trained men is a limited one, and if the opportunity of employing the 3rd alternative is not seized when the fortifications are laid out and executed, a permanent unnecessary strain on our resources in money and in men is the consequence. The expense of such a course may be estimated, but the injury inflicted by an unnecessary absorption of men in time of war cannot be estimated. I submit that this is too serious a consideration to be jostled out of sight as a mere detail of no importance, and that it is trifling with the subject to keep it out of view when making a comparison with the iron-shield system.

In 1869 a Committee was appointed to inquire into the construction, condition, and cost of the fortifications erected, or in course of erection, under 30th and 31st Victoria and previous statutes, of which Admiral the Hon. Sir F. W. Grey, G.C.B., was President. By referring to the Report of that Committee, it will be seen that great importance and value was attached to the Moncrieff or disappearing system. That is the 3rd alternative under our consideration. Embodied in the Report, page 24, there is a Return signed by Sir Wm. Jervois, R.E., headed "Return showing the works in which it is proposed to adopt the Moncrieff gun-carriage system, the armament, nature of defence for the guns, and costs of the designs, as previously

approved and as proposed to be modified according to Moncrieff system."

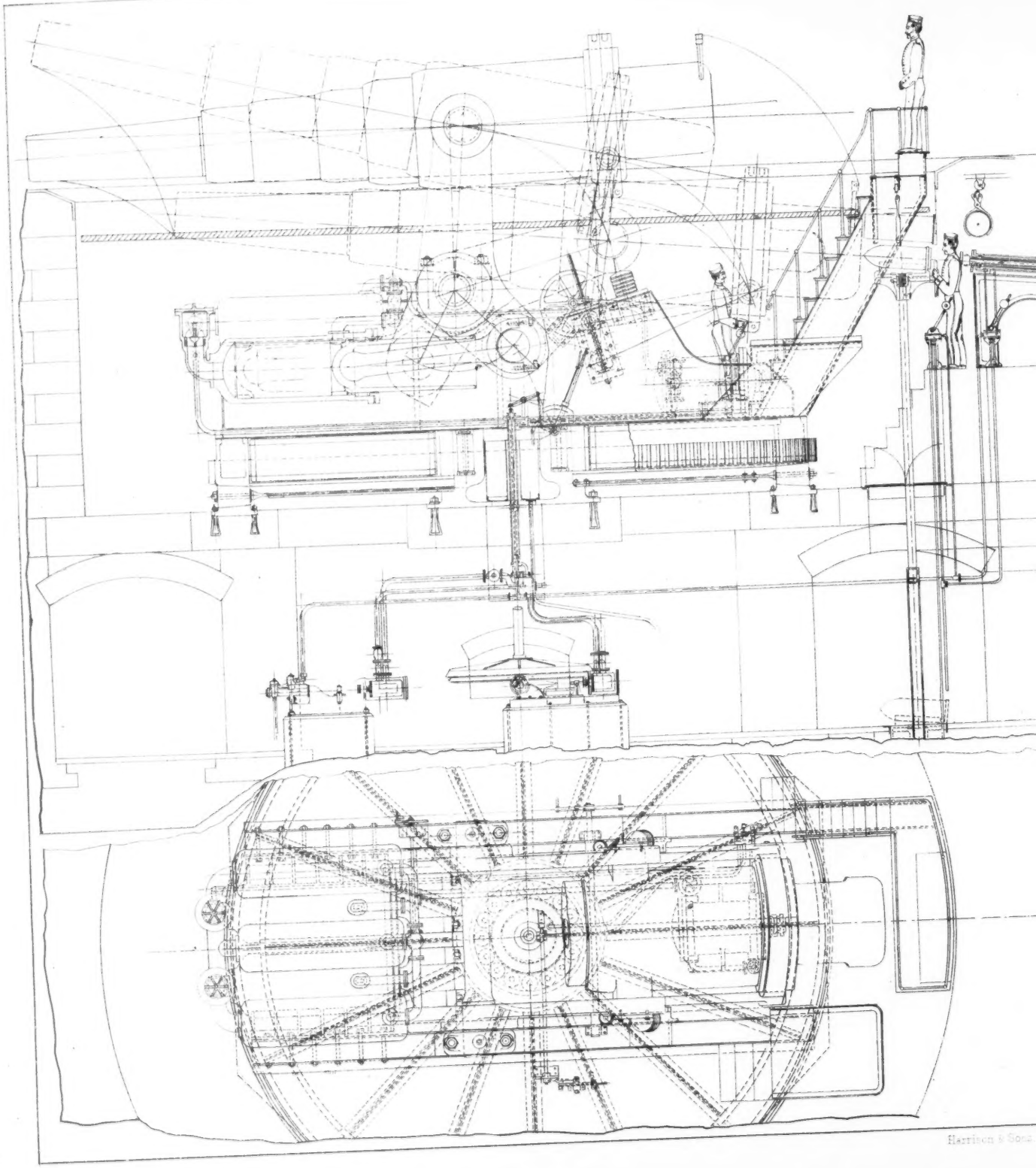
This Return shows that in the comparatively few places where it was deemed advisable to adapt the Moncrieff gun-carriages to the works under consideration, a saving in the cost of these works was effected by their employment of 254,159*l.*, or over a quarter of a million sterling. To this, however, should be added, for the purpose of comparison, another sum of 69,924*l.*, which had to be expended in undoing work already executed, which was rendered useless by the new carriages.

Sir F. W. Grey's Committee, limited by their instructions from the Minister of War, confined their attention exclusively to adaptations of the Moncrieff gun-carriages to four classes of existing batteries, and no estimate was made by or for them of the saving which could be effected by the system when applied to a new position. The great object of attention at that time was the completion on the best methods available of the fortifications erected or in course of erection. It was too late to alter all these works, the carriages were therefore adapted to a few of them.

These circumstances, under which the Moncrieff system was first taken up, have had a most unfortunate effect on its application in this country, from which it has not yet recovered. Although disappearing carriages are advantageous thus used, it is no exaggeration to say that the method of applying them, as a mere adaptation to existing works, deprived them of the greater part of their efficiency. The saving in money which the system is calculated to give was, for the same reason, reduced to a fraction of what it might have been. Had the new system been as developed as it is now, and the works not commenced, they might have been completed on the new system with greater offensive and defensive power than they possess, with much fewer guns, and efficiently defended with a considerable reduction of the artillery garrison which is now required to man them.

At the time Sir F. W. Grey's Committee was sitting, and the above estimate showing a saving of a quarter of a million was made, the Moncrieff system, or in other words the system which is carried out by means of disappearing carriages, was only represented by counter-weight carriages for 7-ton muzzle-loading guns. It can now be applied with ease by means of hydropneumatic carriages to guns of any weight or power (Plate XX) (it is already used up to guns of 40 tons). These carriages, moreover, are superior in nearly every respect to counter-weight carriages, and were therefore strongly recommended by me to the Ordnance Department when I was in their employment for allheavy guns, as soon as I had matured the inventions and conquered the mechanical difficulties which then surrounded this new application of my system.

The price of a hydropneumatic carriage for an 18-ton, or any heavier gun, is about half the price of a counterweight carriage for the same gun. It is much less complicated, occupies less room, gives better cover, and those at any rate for which I am myself responsible, are more difficult to put out of order than a counterweight or com-



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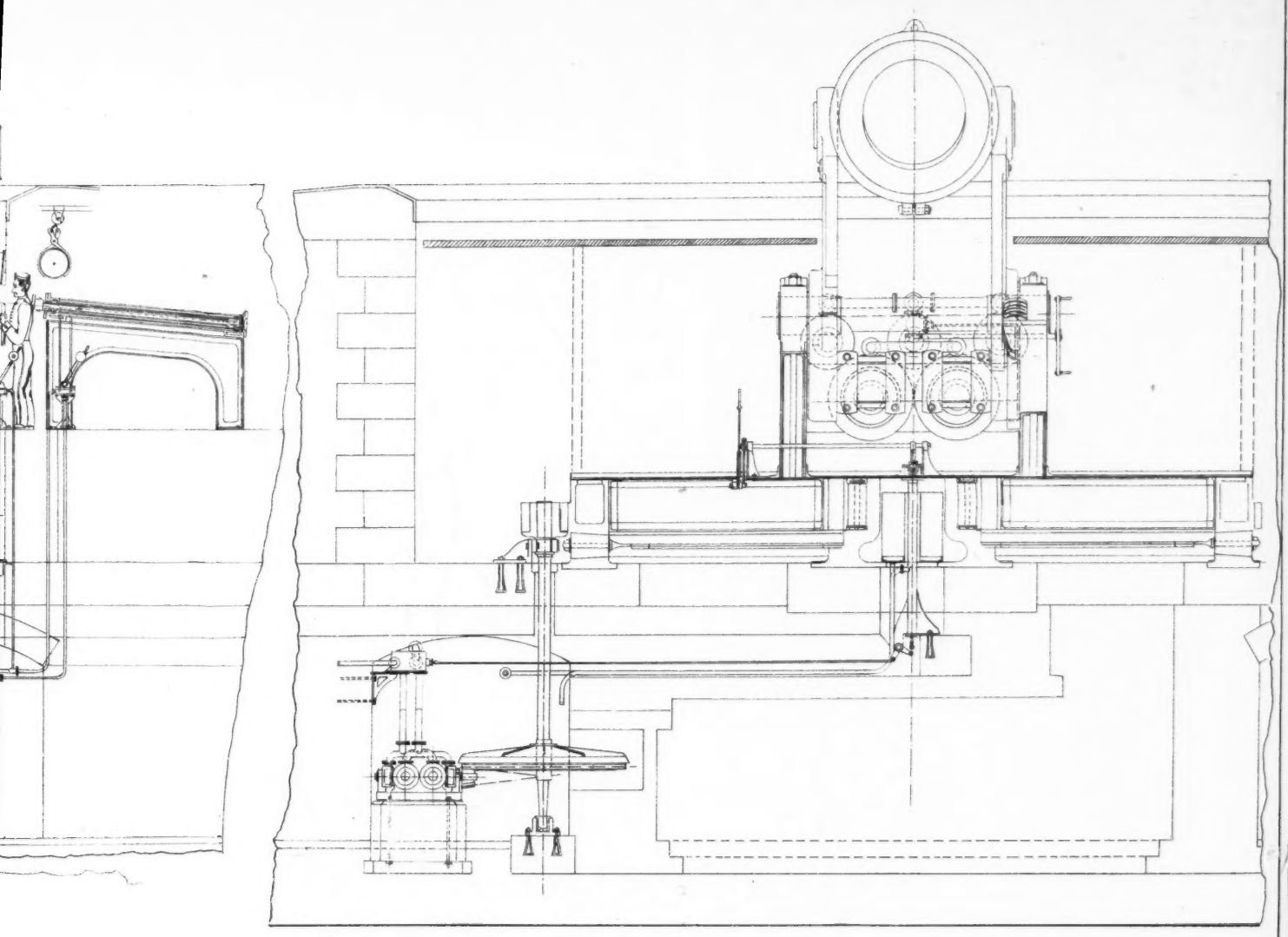

MONCRIEFF H.P. DISAPPEARING CARRIAGE FOR 80 TON B.L. GUN DESIGNED TO MEET THE REQUIREMENTS OF A SPECIAL PERMANENT EMPLACEMENT.

1884.

REFERRED TO IN DISCUSSION PAGE 651.

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mon Service carriage. The height of the interior slope in their emplacements allows of a splinter-proof cover, when such is required, which is completely out of reach of direct fire, and the conditions of these carriages are favourable for the application of hydraulic loading whenever it may be introduced to economize labour in working very heavy guns.

I am indifferent, however, as to what kind of Moncrieff, *i.e.*, disappearing carriages are employed to carry out my system, provided they are efficient; and I do not recommend any one type—but the best that can be produced.

For these reasons, and because there is not time to go into any details, I shall on this occasion confine my remarks entirely to the general question. I may only observe that the passage from counterweight to hydropneumatic agency is a great stride in advance, and that all the recommendations by Committees in favour of using the counterweight carriages apply with still greater force to the use of hydropneumatic carriages with heavy guns; and I have no hesitation in strongly recommending them as the most suitable, efficient, and economical, for carrying out the Moncrieff system in harbour defence.

After all the expenditure that has been incurred on Committees and experiments with Moncrieff (or disappearing) carriages since 1867, after seven different and distinct Committees have investigated and approved of that system, and although there are many Moncrieff carriages mounted in our defences, there is not—incredible as it may seem—one case in Great Britain of a proper application of the system to show of what it is capable. This is indeed sufficiently remarkable, and it is not fully explained by the circumstances above stated. It will not be considered less so when I mention that in 1868 the Ordnance Select Committee, of which General Lefroy was President, recommended that some situation well adapted for the Moncrieff system should be selected for a battery of not fewer than five heavy guns, and a comparative estimate be made between the expense of a Moncrieff battery for this situation, and one for iron shields for the same number of guns. A Report was also made by Lord Northbrook's Committee in 1869, and again by the special Committee on Moncrieff carriages, of which General Eardley Wilmot was President, in 1872, both of which recommended that I should be allowed opportunities of seeing, and of expressing an official opinion on the plans of the new works; and, as previously mentioned, the latter Committee pointedly recommended the system for the defence of the commercial harbours.

These recommendations have had no results; no such battery as that recommended has been made; no designs—except for adaptations to the old system—have been submitted to me; and I am not aware that the system has been considered for harbour defence.

In the Report, dated 23rd July, 1872, it was recommended in the following words:—"Should it, however, be contemplated to project new works for the defence of important positions, or to supplement existing works by others of the present type, the Committee are

strongly of opinion that the designs should be reconsidered with a view to the employment of the Moncrieff carriage; and they would suggest that, with the object of securing harmony between the designs both of works and carriages, Major Moncrieff should be afforded an opportunity of expressing his opinion officially upon the plans that may be proposed."

General Sir J. L. Simmons and Colonel Sir C. Nugent last month in this theatre, in relation to our defences, stated that the Government have not yet adopted any of the recommendations, either of the last Royal Commission or those of the Commission on Commercial Harbours. The Department of the Director of Artillery acts, I presume, on the same principle with regard to the Committees appointed by the Secretary of State for War. There is, however, this rather important difference between the two cases—money is required to carry out the recommendations of a Royal Commission on Defences: whereas in the other case the money has already been spent, and the stage when money can be saved has been reached or nearly reached.

Committees have sat and experimented for fifteen years on this subject at great expenditure to the State, and their recommendations, if carried out, would have saved, and can now save, money on a large scale. The Report, which chiefly bears on expense, recommended the application of the 3rd alternative to commercial harbours, not alone for increased efficiency, but also for economy. Such recommendations, however, remain a dead letter so long as the Ordnance Department refuses disappearing carriages wherewith to carry them out.

To illustrate this, we shall suppose that the two millions are voted this Session, and that that sum is to be expended on harbour defence. That portion devoted to the batteries, as matters stand, can only be spent on a most expensive system—with which it can therefore go but a very short way—on a dangerous system calculated to waste the lives of its defenders, and likely enough to be useless when vigorously attacked, or else the recommendation of the Committee on Moncrieff carriages must be carried out. This last course, however, would not involve cost but, on the contrary, a large saving, because the system it would introdnce is—

1st. Cheaper than the other efficient alternative, gun for gun.

2nd. If properly applied a smaller number of guns might fairly be expected to do the same work: thus saving the price of guns and batteries in that proportion.

3rd. Chiefly, however, would it be a saving, because in addition to all this, the artillery garrison might also be reduced in the same proportion.

The economy so obtained under the heads of guns, of batteries to mount these guns, and of men to fight them is so large, that it assumes a character of national importance in fortifications of any great extent.

The economy within reach under the first head is trifling. The Department of the Director of Artillery, however, appear to confine their attention to the first head. At any rate they abstain from any comparative experiment with shield batteries, have never supplied

carriages for any work, however small, that would illustrate the larger saving, and persistently refuse the only possible means that can now supply such an illustration.

This by itself is to be regretted, but the case becomes worse when the Department avail themselves of the absence of any such illustration as a justification for neglecting the system which alone, without sacrifice of efficiency, can produce this economy, and waste eight valuable years in this attitude. The mere act of delay in such a case induces the belief that something was found wrong to justify it; it will almost appear incredible that the reverse of this was the case. The Engineers and the Navy are dependent on the Department of the Director of Artillery for guns and gun-carriages, but do not always look on the requirements of the Service from the same point of view. I request you to consider in the case of coast works what this delay might involve should any sudden demand for armament arise.

The Department no doubt is entitled to consider everything problematical until it is demonstrated by an example; but are they justified in refusing at the same time the recommendations of important Committees to afford such an example? Are they justified in continuing to manufacture only for a system which is most expensive to the State, while repeatedly and firmly refusing to make and try one 18-ton hydropneumatic carriage belonging to another system which has been officially reported to be superior in both efficiency and economy to the one they employ? Are they justified, after great expenditure by the State on experiments both with counterweight and hydropneumatic carriages—successful beyond the most sanguine expectations of those who initiated them, experiments extending over many years—to suddenly arrest progress the moment it touched a point at which important results could be obtained?—in fact, to stop the application of the new system as soon as it reached those guns that are now employed in iron works, particularly when the special application which they stopped embodied a great improvement on counterweight as applied to heavy guns?

This was, however, done, and every appeal year after year to obtain the reasons for the decision, or a statement of any objections to the special application by those who could analyze it, were sternly refused.

Having complied with every test, been subjected to every ordeal, and delay, which the opponents of the 3rd alternative could suggest, or contrive, are they at last justified in only obtaining their end by an unexplained exercise of power which their position enables them without question to exert, and to maintain, in stopping the manufacture of a single gun-carriage which is not of an accepted type? This, too, while knowing that both the Works Department and at one time the Navy were waiting for the trials thus arrested.

The Department of the Director of Artillery is doubtless convinced that there is no occasion to abandon their policy of opposition to the 3rd alternative, or to doubt the merits of those more expensive, or less efficient methods, which they calmly continue to apply. For they have not only refused urgent appeals requesting that an hydro-

pneumatic carriage for the Service pattern 18-ton gun might be made and tried, but have actually gone out of their way to prevent it being made and tried at the expense of others, after a good deal of that expense had been actually incurred. This repression is adhered to while knowing the wants of the Works Department for many positions; nor was it for want of information as to the value to the Service of an efficient carriage of this kind that such an inexplicable measure was taken.

The Department of the Director of Artillery may believe that such a carriage would not succeed for their special wants, but that belief is not quite justified by simply refusing to see whether it would succeed or not, and declining in every case to state their objections to it or what these wants might be.

The absence of a proper application of my system to a suitable position—for which the Department is responsible—is thus used as the justification first for ignoring its value, and next for refusing to apply it to any heavy gun now suitable for iron shield works; and then the absence of its application to such a gun, for which also they are responsible, is made the justification for continuing to manufacture gun-carriages for iron turrets, casemates, and shields, and may possibly yet be used as a justification for reversing the decision as to barbette batteries, which first created the necessity for iron works.

This policy has now been consistently carried out for *eight* years, and I have no doubt whatever that, notwithstanding the damage it has already inflicted, the Department looks with complacency, and without the slightest self-reproach on the success their policy has achieved; for it has not only continued the old methods, *i.e.*, the 1st and 2nd alternatives, but by their manner of stopping the new one, *i.e.*, the 3rd alternative, they have brought it into discredit, and created a presumption that it has somehow failed.

I hope that I have succeeded to some extent in demonstrating that the 1st of the alternatives is more likely to benefit our enemies when they attack us than ourselves, and that the 2nd alternative is more likely to benefit a few great manufacturers than the public.

The Royal Engineers have many cases to provide for in which efficient Moncrieff carriages for 18-ton or heavier guns would be most valuable. They would know well how to avail themselves of the advantages of the system to which these carriages belong; but the Department of the Director of Artillery have taken the most effectual means of forcing them to employ one of the two other alternative systems, and therefore to design their works more or less on the methods required for these, as without disappearing gun-carriages for heavy guns there is no other resource.

It may here be mentioned that the 3rd alternative is of more importance in our Colonies than at home, because with less money and fewer men a larger area has in their case to be defended, and that defence has to be conducted by citizen soldiers. The Colonies, however, depend on the mother country for *matériel*. In their case it is rather hard that a Department over which they have no control should, without reasons adduced, refuse to look at an alternative specially

suited for their requirements. They cannot afford to risk unnecessarily the lives of their volunteers, or to pay for the luxury of iron plates as the mother country does. They want works, however, in which they—like true Britons as they are—can stand to their guns against all comers.

General Scratchley, who is well known to you, besides his long connection with the War Department and the Royal Arsenal, has had in recent years, with Sir William Jervois, more actual experience in studying and applying coast defence to new positions than perhaps any Engineer Officer in England. For this reason I asked his opinion, and with his permission now give his reply, which, had I received it sooner, I should have made the text of this paper.

"15th April, 1884.

"My dear Moncrieff,

"You ask my opinion on the 'disappearing' system of mounting guns in coast batteries. My reply is, that I have always been in favour of the plan of effecting this by means of hydropneumatic carriages. In my opinion there can be no question that the system is vastly superior to either the simple barbette or side loading methods. In most cases guns can be mounted on disappearing carriages more conveniently and certainly more securely and efficiently than by those plans, but there are certain cases where it is found necessary to place guns at points of vital importance in casemates or even in turrets.

"The disappearing system lends itself to the dispersion and concealment of the armament, and the adoption of varying levels for the guns—three conditions which should always be aimed at, and have been accepted without question by military engineers. An attempt is being made to bring these conditions forward as something never thought of before. The reason why it has not been found practicable o apply them in their entirety to modern works in England is mainly due to our having adhered to the old-fashioned modes of mounting guns in coast batteries. Obstacles have been placed in the way of experiments with disappearing carriages, with the result that we are no further advanced now than we were ten years ago.

"In protesting against this policy of obstruction we should be careful to put the saddle on the right horse.

"So far as I can judge the blame cannot rest on the Engineers. They cannot adopt the system and modify their plans until the Artillery accept the disappearing carriages and the War Department is prepared to supply them. I am told that some gunners object to the hydropneumatic carriages on the grounds that they are complicated and require extra care and attention. I believe this is a complete mistake, and that these carriages will be found not to require any more care and attention, or special skill on the part of the men working them, than the present Service pattern carriages and traversing platforms. But even admitting that they do, I think it mere foolishness to continue the use of appliances which are admitted to be most defective, as exposing the gunners to an unnecessary and dangerous extent, simply on the ground that the proposed system may give more

trouble. At any rate the point can easily be settled by experiment at a moderate expense. As to the question of the cost of the hydropneumatic carriages, it is possible that they may be more expensive, but is this a consideration which should stand in the way of all improvement?

"I advocate the system, not only for all new works, but for existing works where it may be decided to introduce guns of the new type, or new carriages may have to be provided. Existing barbette emplacements can be readily modified without great outlay to receive the disappearing carriages.

"Believe me, yours very truly,
"P. H. SCRATCHLEY.

"Colonel Moncrieff, C.B."

No one, I think, can accuse me of impatience in this matter—indeed I often reproach myself for dereliction of duty to the public in not having sooner appealed. But as there is now again the possibility of expenditure on a larger scale than usual, and also of a repetition of the old policy, which my present protest may possibly prevent, I avail myself of this opportunity to state for your information, for that of the House of Commons, this country, and the Colonies, especially those who are interested in and responsible for public expenditure, that in this class of expenditure the interests of the public have not been sufficiently considered, and that the whole subject has been treated in a spirit that could only lead to one result, and that prejudicial to the Imperial defence, whether of coasts, coaling stations, or harbours.

This policy is not that of any one set of officials, it is a permanent policy. I desire to be absolutely impersonal in what I have to say, in order to make the case sufficiently complete and explicit, and more especially to explain the delay, which produces erroneous impressions.

As the representative of the 3rd alternative before you, and probably the only person able to challenge—with full knowledge of all the facts—the policy adopted towards it, I now formally protest, in the interests of the public, against the way in which this important matter has been treated since I recommended that the 3rd alternative should be carried out by means of an improvement on counterweight;—against the refusal to make, or to allow to be made, an experimental carriage for an 18-ton gun with this improvement; against the neglect to make a comparative trial with shield batteries, or any trial with such guns as are used with shields; and for thus favouring unfairly the 1st and 2nd alternatives at the expense of the 3rd.

I formerly referred to the War Office Committees and the use made of their Reports. I have had some considerable experience with these Committees. I have always succeeded in the end with a Special Committee. If a proposition be true, such a Committee is not likely to endorse the contrary; my success, however, has invariably been the signal for their abolition, and the appointment of another Committee to take up the same subject. This again being repeated, the

same thing follows, and so on. The Ordnance Department have very naturally their own views, and as a corporate body the lapse of time does not make them old—time to them is therefore not of importance. If a Committee does not report according to their views, the subject can be handed to a new Committee—each one in succession has in my case—as far as it was concerned—been abolished when it nearly arrived at all my conclusions. At last, when I pressed the Ordnance Department to adopt a great improvement on the counterweight carriages, for which only I had, in their opinion, been employed, viz., that of hydropneumatic carriages for harbour defence, I was myself abolished—that is, my services were dispensed with as their adviser on the subject, with of course the desired result, which has been partly explained.

It is possible to disregard and to abolish Committees and individuals, but what cannot be abolished are principles founded upon truth, *magna est veritas et prevalebit*. If true that the earth will deflect the heaviest projectile striking within a certain angle; that a superior slope *en glacis* is better against such a projectile than the strongest iron shield; that the vertical error is greater than the horizontal one in artillery fire; and that my system abrogates the old law rendering an increase of protection a decrease in offensive power; and the converse, so long will the system which benefits by these laws be superior to those which do not.

Time has not altered these conditions, my conclusions are as sound as when they were first arrived at and expounded, and I ask, has not the improvement of artillery in the meantime confirmed them, and weakened the case of the two first alternatives? In all that time the Ordnance Department have not been able openly to allege one serious defect in my system to justify their neglect.

It is a noteworthy fact that sailors, who conduct the offensive, that soldiers of the greatest experience, and all those who have carefully studied this question, are at one in regard to the 3rd alternative.

It is true, on the other hand, that the Department of the Director of Artillery do not love it. I fear it has given much trouble. I have recently been informed that it is so obnoxious in that quarter that rather than allow one specimen to be produced, which might lead to its general application to harbour defence, some of the Officers of the Department would prefer to apply the improved barbette batteries for this purpose. It is evidently a waste of energy to convert Special Committees and to enlist outside professional opinion—it is the Department of Director of Artillery itself that has to be converted. An engineer friend of mine, of rank and great experience, discussing the matter with an artilleryman, who confessed to having the War Office opinion on this subject, observed to him that five minutes under machine gun-fire, in his favourite battery, would entirely convert him.

In the interest of the Service I devoutly wish for the conversion of the Department of the Director of Artillery, although not with so unkind an ordeal. If the public only knew the magnitude of the interests involved, or if the subject were not shrouded in technical

terms, and obscured by a mass of confused and contradictory arguments which conceal its real nature, perhaps some equally effective but less violent method of conversion might be applied. They may, however, some day be converted by deputy, by the slaughter of their juniors in time of war. I hope this may not be when it is too late.

I know that some whom I now address may sympathize with the exclusion of the 3rd alternative from our coast fortifications. Notwithstanding this I am certain it is the system of the future. The authorities have already entailed a heavy loss on the State by delaying its application to heavy guns, and it is quite possible that millions of money may yet be wasted, and many valuable lives be sacrificed, because it has not been applied; but I now predict, with the voice of one whose enthusiasm, though not his faith, is extinguished, but whose knowledge I hope is increased, that, although I may probably not live to see it, there are some present in this theatre who will live to see my system generally adopted for this purpose, a time when it will be acknowledged superior to all existing methods of fortification for harbour defence.

Captain ORDE-BROWN (late R.A.): I should like to ask Colonel Moncrieff a question, which I think would naturally be raised by this paper, namely, if the whole opposition to his system has laid so entirely with our War Office, how is it that it has never been adopted by foreign Powers? One could understand that as far as the Colonies are concerned, the difficulties raised by our Director of Artillery would practically defeat its introduction; but with reference to foreign Powers, that would not be the case, and perhaps Colonel Moncrieff can tell us what opinions they have given on the subject.

Admiral BOYS: I have only a few words to say about this paper. I should first like to correct an error which Colonel Moncrieff has fallen into with regard to the construction of the gun-carriages for the Navy. He said that the Navy depended upon the War Office for the construction of their gun-carriages. That is an error, because at the present time the gun-carriages for the Navy are entirely under their own control. The War Department only constructs for them the same as any manufacturer might do, as the Admiralty have taken that department entirely into their own hands. With regard to the system for the defence of commercial ports, it happened to be my duty three years ago to go round the commercial ports as a member of a Defence Committee, and there appeared to me to be no opposite view or no second opinion, but that in certain positions the disappearing system is the best one for the defence of mercantile ports, because by adopting that plan the guns can be dispersed, and in attacking them from ships when the guns are down for loading, and there is only a green slope up to the gunpit, there is nothing to be seen and no distinct object to aim at. I must say my own impression is that there has never been opposition to the Moncrieff system by any special department, but that it has hitherto only been successfully carried out up to a certain size of gun. I know at this moment the Moncrieff system is adopted for 7-inch guns upon the counterweight system, in the defences of the Bristol Channel, and I should like to ask Colonel Moncrieff as to that point, because my impression has been, not that the system has been put on one side, but that the details have not been successfully carried out for the heavier nature of guns. I wish moreover to ask what is the heaviest kind of gun that has been actually experimented on, or has been successfully mounted upon *Moncrieff's hydropneumatic* system?

Lieutenant-Colonel A. W. DUNCAN, R.A.: I myself practised with one of the first guns mounted upon Colonel Moncrieff's principle, and I candidly confess that, as an Officer of artillery, I would far sooner fight a battery of guns upon his principle than upon any other. There is no comparison in my opinion between the

Moncrieff system and the system of defending guns by means of iron shields. What Colonel Moncrieff has said with regard to machine-guns is most undoubtedly true, and I have no doubt whatsoever as a practical man that his system has enormous advantages. My impression has all along been that the great objection to it has arisen from the enormous iron interests in this country, and perhaps not a little from official jealousy.

Admiral RYDER: Colonel Moncrieff lays great stress on the advantage which he claims for his system, on account of the magazines being under the *terrepleine*, and he points out as a great disadvantage to the other alternative, that their magazines are above the *terrepleine*. I should like to ask whether it is essential that their magazines should be above the *terrepleine*, for it seems to me it would be just as easy for them to put their magazines below as it is for him. I should also like to ask how many of Colonel Moncrieff's guns are mounted by the Government. I think every engineer and every artilleryman who has studied the question has come to the same conclusion, namely, that for the defence of harbours, as the Americans learned to their cost, scattered guns are the most effective. Some of us saw in the Wasp Battery at Sebastopol guns mounted above a certain elevation, and scattered in such a way that you could not see where they were, and could not point your guns at them. This is how the guns should be placed to defend harbours. There is no difference of opinion about that. Scattered guns are the guns of the future for harbour defence, and Colonel Moncrieff steps in with what he thinks—and many persons agree with him—is the best way of mounting single guns. I should fancy there is very little difference of opinion about that. I am very sorry that we are not favoured with the presence of Sir Lintorn Simmons, a distinguished engineer Officer, who has, I believe, strong views on this point. Whether being on active service his mouth is closed, I do not know, but I believe he has always supported Colonel Moncrieff's gun-carriages most warmly and strongly. The Royal Engineers wish to have single guns in pits on disappearing carriages for harbour defence, but are not allowed to have them. The Carriage Department cannot or will not make them. I have listened with the greatest care to the paper, and it does seem really very astonishing that after *seven* Committees have reported, all agreeing and confirming, as far as I understand, the views of the gallant Officer who has written this paper, still the mind of some person or department is so "thickly plated," that Colonel Moncrieff cannot get his shot into it. I have noticed in my experience that it is sometimes a mistake to prove your case too thoroughly; it annoys people. I have felt it myself when a person proves to me that I am so absolutely wrong that I cannot say a single word in my own defence; it is utterly detestable, and I am tempted to hate the man who does it, and oppose him more and more. Probably that may have something to do with this case.

Captain CHARLES JOHNSON, R.N.: Will Colonel Moncrieff kindly tell us what the cost of mounting a gun on his system would be? Because we all know that that has a good deal to do with the question.

Admiral SELWYN: I was going to rise on that very question of economy. There is no proposition or syllogism in logic so well established as that the cheapest way of doing what will not answer is to do nothing at all. Now a shield battery, which is made at one epoch while guns are always advancing in power, and is to be fired at at some other unknown epoch, is in the position of being one of those things which necessarily cannot answer for the purpose for which it is designed. At the moment at which it is attacked, it cannot be armed with an equal plate in thickness or value to the gun brought against it, because it takes longer to build forts or put shields on them, or even to restore better kinds of shields, than it does to make guns and bring them against it. So that the whole shield question fails entirely *ab initio* in comparison with the Moncrieff system, because it never can be in a position to answer, while the Moncrieff system must be always in a position to answer. No possible gun that can ever be brought against a Moncrieff battery can have a greater effect than the guns in use at the time it is built. You may have a shot of unlimited size, but earth is a shield of much greater resisting power than all the things which man can bring against it. There is no difficulty whatever as regards the engineering part of the question, even in revetting by an artificial glacis the existing forts. On that ground alone there is no comparison whatever between the

best protection by shield and the ordinary protection which the Moncrieff batteries give. When it comes to the question of disposing of the guns *en barbette*, and protecting those who serve them, I confess I always thought that when the artilleryman who had to serve the gun was there, it was necessary that the gun should be there also, and if the gun is to be exposed to shot which may overturn it in a second, what is the use of the men being there, they might just as well have been killed as far as that gun is concerned, though of course they might go to work on some other battery? Therefore I cannot approve of the so-called new idea of making a protected barbette with a gun which is turned sideways in order to be loaded, remaining rather more exposed during the loading than during the firing, provided only the men are out of sight, the gun always being in sight, and always offering a mark to aim at. The one thing that a sailor has no opinion of is firing at something that he cannot see. I do not think any of us like to have to aim at an object that we cannot see, though it was once done successfully at Ismailia, from the masthead direction. I should like to ask, supposing we went to war to-morrow, how long it would take to build forts in places which we should discover were likely to be attacked, not only existing harbours and ports, but places where you might probably expect an offensive movement with great effect, and which have been neglected because there was not money enough to provide the contractors with their wages. Admiral Ryder has thrown out a very valuable suggestion, namely, that Colonel Moncrieff should not make himself too offensive by being too much in the right, and perhaps he could not do better than to introduce some form of defensive work in which a great deal of iron and an enormous quantity of masonry, and therefore large contracts should still be required, because then a great deal of the opposition might disappear. If scientific Committees when appointed are not to be listened to, for what earthly reason do scientific Committees exist? Why do we give training in theory to the best men in the country that examination can discover, and then set them to work on Committees to decide what ought to be done, if afterwards there is some shadowy power behind, or department which prevents the recommendations of the most scientific Committees being listened to? I know that, however shadowy that power may be, it constitutes the greatest real danger that a nation can suffer from. At every meeting that I have attended in this Institution where this question has been brought before it, there has been a consensus of opinion which all the trials have justified. Why then is it that we have still to regret this opposition? Strong vested interests may have something to do with it; there may be something in the idea that a profession is unwilling to accept teaching from the outside; there may be something in the idea that our present system secures magnificent theorists but very bad practical men, and that they hate practical men because they upset theory. It must be recollected that in a matter of this kind John Bull submits for a long time to deception, but he is very apt to get angry after a long course of it, particularly if it is accompanied by incapacity, either in his servants or in his governors, and that anger is unmistakably shown. It may result in the sweeping away of a whole profession or a whole department, and substituting better men, the country saying, "We will rather not have such a profession if by it we cannot gain the results we expect. If it gives us all profession and no practice, if the nation is left at a critical moment without proper defence, because you, the professors, have not been able to arrange in your own minds whom you should listen to, we shall hold the whole profession responsible, although the acts may have been those of individuals."

Colonel MONCRIEFF: Perhaps Mr. Anderson will be able to answer Captain Orde Browne's question about foreign Governments.

Mr. ANDERSON, C.E.: I am not a military man, and therefore I feel a difficulty in addressing an assembly such as this. But I have had to make Moncrieff carriages, and therefore I may be presumed to know something about them. The drawings on the wall show a carriage for a pair of 12-inch B.L.R G. of 40 tons weight, which have stood the test of eight years' service very well indeed. Last June I visited St. Petersburg at the request of the Russian Admiralty to advise them as to the best form of carriage for their heavy ordnance. I submitted several plans to the Committee appointed to consider the matter, and a modification of the Albani carriage was approved, and recommended for adoption to the Minister of Marine. The

Minister objected to the recommendations on the ground that they had already a first-rate disappearing carriage in the Black Sea, of which the very best reports had always been received. That carriage was for two 40-ton guns on the Moncrieff system, and he saw no reason why they should not adhere to that plan. He further said he should go to the Black Sea himself in the autumn and look into the matter personally. He did go to the Black Sea. He went on a cruize in the circular ironclad "Vice-Admiral Popoff," on board of which the Moncrieff gun-carriages were fitted, and the result was that the system has been adopted for the new Russian ironclads for mounting the 12-inch 50-ton guns, 35 calibres long, with a muzzle velocity of 1,950 feet a second. I have not the smallest hesitation in saying that the carriages for these fine weapons will act quite as well as the ones they have already had. The fact is, the theory is so plain and clear, that there is no difficulty whatever in mounting guns of any size, and a carriage on the hydropneumatic system for a 16-inch 80-ton gun has already been worked out for coast defence, and is exhibited on the wall (Plate XX). I can quite endorse what Colonel Moncrieff has said about the difficulty of getting a hydropneumatic carriage for a big gun tried in this country, for I myself offered General Campbell to make gratuitously a carriage to be tried at Shoeburyness if the Government would lend me an 18-ton gun to try it with. The offer was refused.[1] The Ordnance Department undoubtedly had the opportunity of trying the experiment free of all cost if they had pleased so to do. There is one subject which I think ought to be made public as much as possible, and that is our ignorance as to the effect of heavy fire on revolving turrets. My experience as a mechanic of a good many years' standing leads me to think that the revolving turrets which are being put up in some places are landing us in a fool's paradise. The sufficiency of the turrets to resist heavy fire should be tested by trying what a shot from the "Inflexible" would do against the turrets of Dover harbour. My belief is that the turret would be so damaged by a single 16-inch shell that it would be impossible to work it any more: at any rate the experiment, though it will be a costly one, is worth trying. We are putting a pair of most costly guns into a turret, and we do not know in the least what will happen when it is struck by a heavy shot. The experiments made a great many years ago with the "Glatton" go for nothing now, because they were made with comparatively light artillery; but any one who has seen, as I have, the destruction wrought at Alexandria by the heavy shot of the "Inflexible," will, I think, admit that the experiment should be tried, especially if the revolving turret system of defence is to be further extended.[2]

Mr. B. F. Hawksley: I should apologize as a layman, in no way whatever connected with the Service, for venturing in this assembly to make even a single observation; but it is impossible for a taxpayer to have listened to what has been said to-day, and to have heard from the members of the Services who have spoken of the enormous saving which by common consent the adoption of the Moncrieff system would effect for the country, without expressing utter astonishment that it has not been adopted by the proper departments. It is impossible, I say, for a layman having any knowledge of this subject to understand why with Committee after Committee reporting, as I understand these Committees have done, in favour of the Moncrieff system, and recommending that experiments should be tried, no practical step has been taken. Colonel Moncrieff is not informed that as the result of the consideration of the War Department of the Reports of these Committees, his system is considered to be a failure. He is simply told that the recommendation of the Committees will not be adopted, and he himself, as he graphically put it, is abolished. That abolition took place in the year 1875 at the very time when, by the substitution of hydropneumatics for counterweights, the application of the Moncrieff system to heavy guns was matured. In 1874 Committees recommended that experiments

[1] Colonel Moncrieff also made similar offers.

[2] The energy of one of the bolts of the "Inflexible" striking, say, at 2,000 yards' range, would be represented by the whole of the Dover turret, which weighs 750 tons, rising 16 feet into the air. Is it conceivable that no derangement would result from such a blow?

should be made as to the application of the Moncrieff system by means of hydropneumatics to carriages for siege guns, and also for heavy guns. The reward to Colonel Moncrieff was the termination of his service engagement with the Government! However, subsequently two siege carriages were made by Colonel Moncrieff at the expense of the Government. Those two carriages were reported upon in January, 1880, by the Committee on Siege Carriages, presided over by Colonel R. Curtis, R.A., and what do they say? "The Committee consider that basing their opinion on the trials they have carried out, this (the hydropneumatic) principle is suitable for the Service, because there is no danger or fear of explosion by the use of air at the pressures necessary for working these carriages." Here is an absolute recommendation, but nothing is done.[1] As to the recommendation that the applicability of the system by hydropneumatics to heavy guns should be tested by experiments, we have heard from the lecturer and Mr. Anderson that the Government would neither experiment nor lend an 18-ton gun for the purpose of experiments being carried out at the expense of others! How is all this to be remedied? I do not know how the matter can be brought home to the proper authorities. Is the remedy to be sought in Parliament or at the bar of public opinion, for it is the public who are the interested parties? When taxpayers are told, as we have been told to-day, that because a system favourably reported upon and recommended is not adopted, the country is deprived of the opportunity of saving a quarter of a million of money, it seems perfectly unintelligible that they should not have the means of insisting upon the system being promptly adopted, and the saving effected. It so happens that nine months ago the utility of the Moncrieff system, as applied by hydropneumatics, came before the Privy Council, Colonel Moncrieff having applied for an extension of his patent protecting this application. The Government appeared by the Attorney-General, and stated that they attached the greatest value to the Moncrieff system, not merely as applied by counterweight, but generally, and in connection with the case before the Council, particularly to the application of hydropneumatics, and contended that by virtue of a bargain made with Colonel Moncrieff in 1869, on the recommendation of Lord Northbrook's Committee, they were entitled to the hydropneumatic application of the system, notwithstanding the termination of the Colonel's service engagement with the Government. At that moment there was a Bill before Parliament introduced by the Government, by which the reservation invariably inserted in Letters Patent in favour of the Crown was proposed to be abandoned, provision being made that inventors should be remunerated when their inventions were used by the Crown on terms to be settled, in default of agreement, by the Treasury. That Bill passed into law, and is now in force. Notwithstanding the view that the introduction of the Bill showed the Government to take of the privileges of inventors, they attached so much importance to Colonel Moncrieff's invention, that they induced the Privy Council to insert in the Renewal Letters Patent a stipulation that not only the Government officials, but any manufacturer in the United Kingdom who contracted for the supply of ordnance and projectiles to the Government, should be at liberty in executing the contract to use the invention without the payment of any royalty or charge whatever. Is there no means by which pressure can be put upon the Government? It occurs to me there should be a practical outcome of discussions of this character. There has been no sort of defence made. We are told that this is the very best system, and yet no attempt whatever is made, as far as I can see, to get it introduced into the Service properly and in its entirety. I would respectfully ask whether it is possible by any means which are at the disposal of this Institution to bring the matter more prominently before the Government.

Colonel MONCRIEFF, in reply, said: Captain Orde Brown asked whether the system had been applied by foreign countries. In answer to his question I refer to the remarks of Mr. Anderson. I also beg to inform him that the system is applied to my knowledge in other countries; it is now applied without reference to me, and

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[1] It has since been ascertained that six siege carriages have been made by Messrs. Easton and Anderson under Colonel Moncrieff's superintendence for the Government.

therefore I cannot give full particulars. Unfortunately the delays which have been caused at home have prevented my deriving the advantage from its application outside which I might have otherwise got. The largest guns mounted, and which have now been successfully worked for a long time, are 40-ton guns; the largest contemplated are 80-ton guns, the drawings of which are on the screen (Plate XX). Admiral Ryder asked me if there was any necessity for placing the magazines in the shield batteries in a different position from those in the Moncrieff. Of course it is of great importance to have the expense magazine on the same level as the gun, so that the inconvenience of carrying the ammunition should be reduced as much as possible. You will observe in the Moncrieff battery the gun is worked below the surface level, and the magazine is on the same level on which the gun is worked. In the case of shields, the magazine is relatively to the gun also on the same level, but the shield emplacement is necessarily entirely above the surface of the ground, while the Moncrieff is below the surface, and consequently quite protected. In answer to Captain Johnson as to the cost of the Moncrieff system, it is less gun for gun than the shield system. It can indeed be efficiently constructed for much less than a shield battery, for it may consist of any materials, in fact, there is no reason why the Moncrieff gun, provided the foundations are strong enough, should not be fired over the simplest form of earthwork. It is not even necessary to use concrete. The form which is used in permanent works by the English Government for Moncrieff emplacements, and which I believe to be the best, is simply a dome of concrete costing a very moderate sum. With regard to the carriage itself, I should say that a Moncrieff carriage should cost very little more than an ordinary Service carriage and platform for the same class of gun. Admiral Ryder asked how many guns there were mounted in England. I may say that since I left the Department, I have had the greatest difficulty in getting any information about my system. I do not know in the least where or how my system has been applied. All I know is that while I was in the Department 7- and 12-ton guns on Moncrieff counterweight carriages were mounted in the defences of the Severn, Cork Harbour, and other home stations, and that the Moncrieff carriages were also used in Bermuda and other Colonial stations, that since I left the Ordnance Department, the Artillery Department have been manufacturing Moncrieff counterweight carriages in the Royal Arsenal for various positions, and that I have supplied hydropneumatic carriages for siege artillery, which are now in the Service. I regret that I am not in a position to give you the statistics of my own system. Perhaps Mr. Anderson will answer the question as to the cost of carriages more definitely.[1]

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[1] There was not time to read the following letter addressed to me eight years ago by a distinguished Officer—alas! no longer here; but it bears so directly on the subject, that I make no apology for inserting it.

March, 1876. (Copy).

Letter from Admiral Sir H. Codrington, G.C.B.

Dear Major Moncrieff,

I regret much to hear that you have not yet had the opportunity of developing your admirable system of mounting guns as you proposed, especially the heavier guns, on the hydraulic principle. The experiments which I saw of that principle in actual practice at the butts at Woolwich some time since leave no doubt on my mind as to its efficiency, and as to its application to still heavier guns, and I cannot understand why a system so advantageous to the public service, both as to efficiency, and also in an economical point of view, should not be fully and fairly gone into.

As an old naval Officer, I have had to consider carefully the question of our men-of-war having to cope with batteries, especially with those constructed in late years.

I quite admit the general principle that, in these days, a ship is not equal in power to a battery, and should not be committed unaided to a duel in a fixed position with a battery of approximate gun-power.

Again, there are positions where a ship threading a narrow channel is at the

Mr. ANDERSON: I think in heavy guns, where you must use hydraulic apparatus of some kind or other, the Moncrieff gun-carriages would cost about 25 to 30 per cent. more than the ordinary open barbette or casemate carriages, but it is a mistake to compare the Moncrieff carriage with an ordinary carriage by itself; you must compare the relative cost of complete batteries. Although a Moncrieff carriage in itself is 25 per cent. dearer, I should think the emplacement for an ordinary carriage protected by armour or turret would be about five times dearer than a Moncrieff emplacement, so that the case of a complete battery would turn out enormously to the advantage of the Moncrieff carriage, especially when the defences are widely spread, as they should be. A bank of earth of any kind is all that is required for the Moncrieff gun; the revetments shown on the diagrams are simply to bring the gun more completely under cover. The foundation required for the pivot at the bottom is not much, the horizontal strain due to the recoil of the gun

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greatest disadvantage compared to a battery of even small power that rakes that passage.

But there are circumstances in which the fire of a ship choosing her position on the weak side of shore defences may run them with comparative impunity to herself.

It is not merely with old works that this is the case; but I refer to modern works, some casemated, and others beautifully built, and strengthened with heavy iron armour. It is easy, but therefore unnecessary to give instances, for which we need not go far.

In contrasting your system with the iron casemate system, I take that which I consider the highest and best development of yours, namely, the hydraulic system of mounting.

First of all, as to the expense of constructing and fitting of batteries and guns, the difference is of course immensely in your favour.

I need not go into figures, but the contrast is well worthy the attention of the House of Commons when the question of new defensive works comes before them.

But as a naval Officer I dwell on the comparative efficiency on service of the two systems.

The extreme thickness through the face of these modern iron casemated works at the embrasures reduces very much the lateral range of training the guns; and consequently a battery of nominally great power, if attacked by a ship from some point on which few, if any, of the battery's guns can be trained to bear on its enemy, may prove really inferior to that floating assailant which can bring her whole broadside to bear on what is comparatively the blind side of the battery. But where is the blind side of a battery really constructed on your system? There is nothing on the parapet to limit the arc of training right or left; and no enemy could approach it, or place himself within range of it without meeting its full power wherever he might be. Then comes the question, is your system of mounting guns limited in its application as to weight of gun?

Looking at the enormous increase of weight of gun that each year brings forth, the counterpoise plan would have probably become too cumbrous and expensive; the guns are in fact outgrowing it.

But the hydraulic principle has done so well in the heavy gun with which it has been tried, and gives such promise of success with still heavier guns, that it is most desirable that it should be thoroughly tested by its application to heavier guns in succession.

It is not only as a matter of economy in gun and in battery, but also as a question of real efficiency in action, that I do hope you may yet have an opportunity of having your hydraulic system of mounting guns fairly and fully tested.

Believe me, dear Major Moncrieff,

Yours truly,

H. J. CODRINGTON,

Admiral.

112, Eaton Square,

15th March, 1876.

Major Moncrieff.

Mr. ANDERSON: I think in heavy guns, where you must use hydraulic apparatus of some kind or other, the Moncrieff gun-carriages would cost about 25 to 30 per cent. more than the ordinary open barbette or casemate carriages, but it is a mistake to compare the Moncrieff carriage with an ordinary carriage by itself; you must compare the relative cost of complete batteries. Although a Moncrieff carriage in itself is 25 per cent. dearer, I should think the emplacement for an ordinary carriage protected by armour or turret would be about five times dearer than a Moncrieff emplacement, so that the case of a complete battery would turn out enormously to the advantage of the Moncrieff carriage, especially when the defences are widely spread, as they should be. A bank of earth of any kind is all that is required for the Moncrieff gun; the revetments shown on the diagrams are simply to bring the gun more completely under cover. The foundation required for the pivot at the bottom is not much, the horizontal strain due to the recoil of the gun

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greatest disadvantage compared to a battery of even small power that rakes that passage.

But there are circumstances in which the fire of a ship choosing her position on the weak side of shore defences may run them with comparative impunity to herself.

It is not merely with old works that this is the case; but I refer to modern works, some casemated, and others beautifully built, and strengthened with heavy iron armour. It is easy, but therefore unnecessary to give instances, for which we need not go far.

In contrasting your system with the iron casemate system, I take that which I consider the highest and best development of yours, namely, the hydraulic system of mounting.

First of all, as to the expense of constructing and fitting of batteries and guns, the difference is of course immensely in your favour.

I need not go into figures, but the contrast is well worthy the attention of the House of Commons when the question of new defensive works comes before them.

But as a naval Officer I dwell on the comparative efficiency on service of the two systems.

The extreme thickness through the face of these modern iron casemated works at the embrasures reduces very much the lateral range of training the guns; and consequently a battery of nominally great power, if attacked by a ship from some point on which few, if any, of the battery's guns can be trained to bear on its enemy, may prove really inferior to that floating assailant which can bring her whole broadside to bear on what is comparatively the blind side of the battery. But where is the blind side of a battery really constructed on your system? There is nothing on the parapet to limit the arc of training right or left; and no enemy could approach it, or place himself within range of it without meeting its full power wherever he might be. Then comes the question, is your system of mounting guns limited in its application as to weight of gun?

Looking at the enormous increase of weight of gun that each year brings forth, the counterpoise plan would have probably become too cumbrous and expensive; the guns are in fact outgrowing it.

But the hydraulic principle has done so well in the heavy gun with which it has been tried, and gives such promise of success with still heavier guns, that it is most desirable that it should be thoroughly tested by its application to heavier guns in succession.

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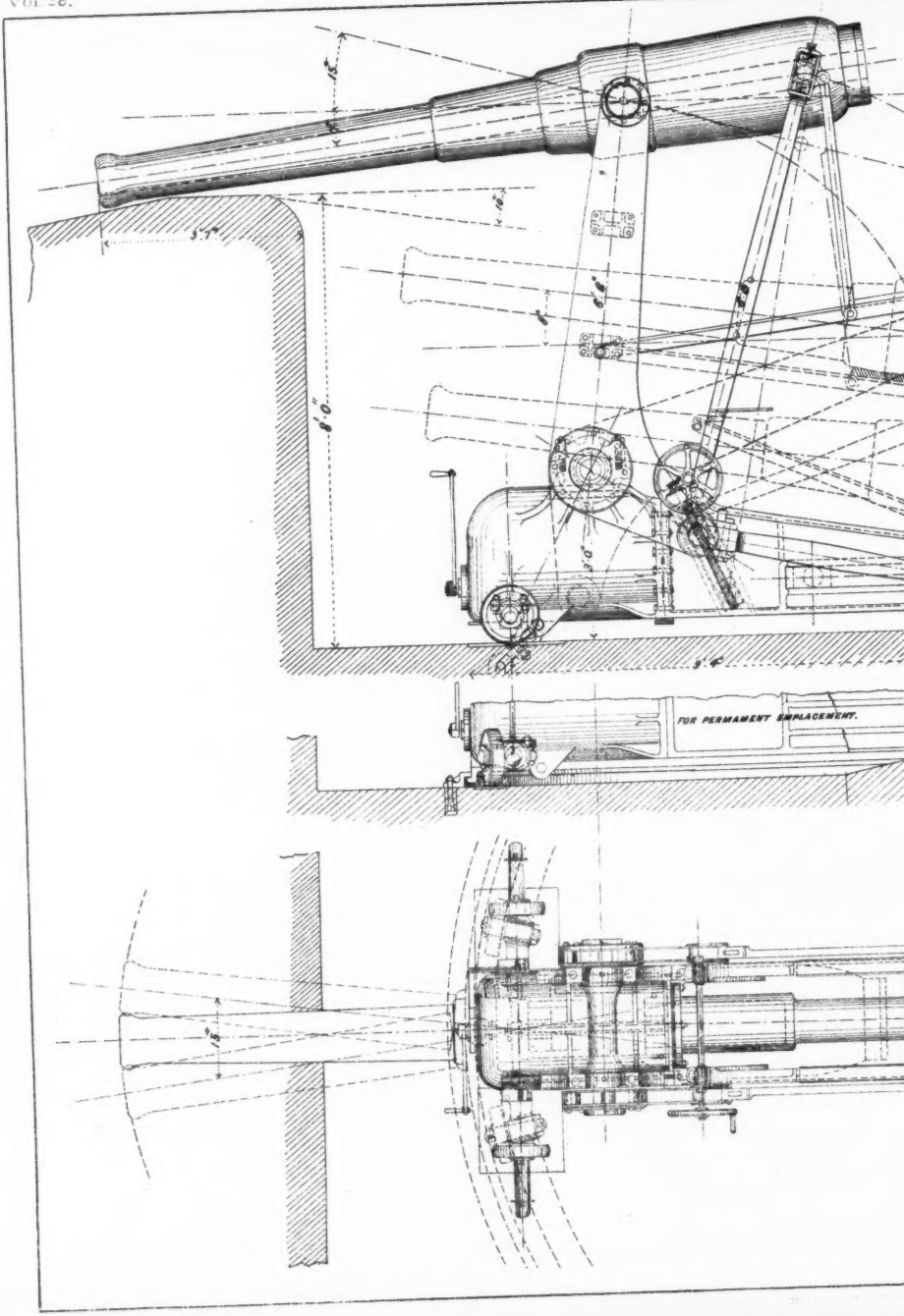
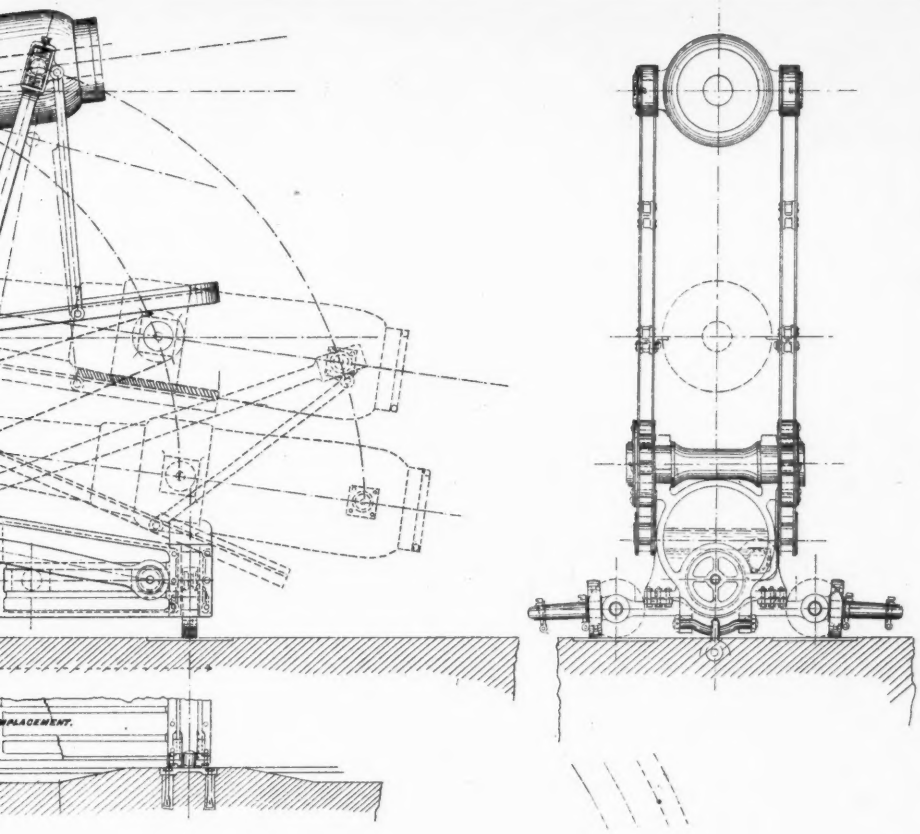
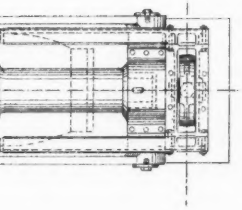
Major Moncrieff.


FOR PERMANENT EMPLACEMENT.



DESIGN FOR H.P. DISAPPEARING CARRIAGE FOR 6" B.L. GUN. PREPARED AT THE REQUEST OF D. OF A., AND SUBMITTED IN 1880.



THIS CARRIAGE IS DESIGNED FOR EASY MOVEMENT FROM ONE EMPLACEMENT TO ANOTHER. IT IS SUPPLIED WITH AXLES FOR TRAVELLING WHEELS AND PROVISIONS FOR EITHER FRONT OR REAR PIVOTING, AND IS ARRANGED SO THAT THE GUN CAN BE MOUNTED ON IT FROM A SLING CART WITH EASE AND WITH RAPIDITY. IT HAS ALSO AUTOMATIC THROTTLING BOTH FOR THE RECOIL AND RUNNING UP.

REFERRED TO IN DISCUSSION PAGE 655.

being moderate. On that diagram is represented a carriage which is being tried now at Shoeburyness. I have attempted to cheapen it as much as possible, to meet the objections of the Department, by making a cast-iron pneumatic cylinder of moderate weight, but I have met with two accidents already, due to the treacherous nature of the material. This carriage is supposed to be a typical arrangement for a coast defence battery. Unfortunately it is adapted to an obsolete short 6·6-inch M.L.R.G., instead of one of the modern heavy pieces of ordnance. On the wall is a diagram of an excellent carriage for a 6-inch B.L.R.G. (Plate XXI), which was submitted to the Department by Colonel Moncrieff, but not adopted. If the Department really wants the right thing, there it is.

The CHAIRMAN: After the very interesting lecture that we have had from Colonel Moncrieff, I am sure the very least that I, as your Chairman, can be expected to do is to move him a vote of thanks. I may be permitted to observe that having occasionally presided here, and having attended many lectures, I have seldom seen an occasion on which there was such an unanimity of agreement. I have heard no criticism which would require any reply. Questions have been asked, but the replies seem to have been satisfactory, and we have now before us the fact that a more economical and a more efficient system of arming our coast defence has been put before the public by certain Committees, and that at this moment it is not adopted. That I believe is the absolute fact which is introduced to the notice of the public after some fifteen years of experiment and of attempts to introduce a system which would be more economical and more efficient than any other. An honourable gentleman has asked how it is that this is not made known to the public, and has suggested that another place to which I belong is one of the places where it might be discussed. I venture to say that no discussion there is likely, so far as I know, to have even an opportunity of being heard, and that if it were, I suspect the individual who introduced it would find himself in the same position as the seven Committees. But I see a noble friend of mine here who is an authority in these matters, and there is another place where subjects of this sort might be introduced with some advantage, and where the public mind might be awakened to an intelligent perception of the advantages of Colonel Moncrieff's system. It is not for me to suggest that course, but I must say that the publication of the lecture to-day, the favourable reception of the lecturer in this theatre, and the absolute absence of any hostile criticism in a society so constituted that the most severe and the most relentless critics might have been expected to be present, must, I think, assure the public that the lecturer has to-day done his duty to the public in making the suggestions which he has done, and I can only hope that the public may insist upon their adoption. I am sure I am but performing my duty in thanking Colonel Moncrieff for this most interesting lecture which he has given us.

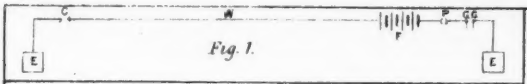


Fig. 1.

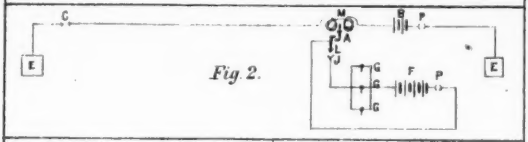


Fig. 2.

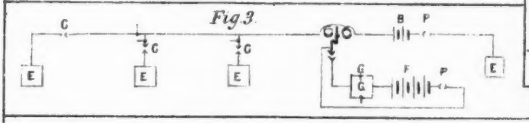


Fig. 3.

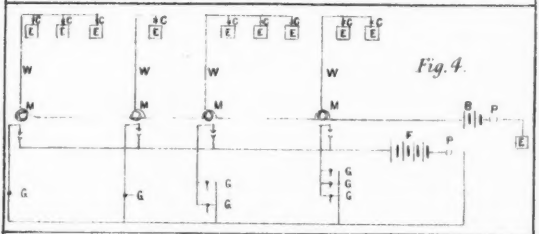


Fig. 4.

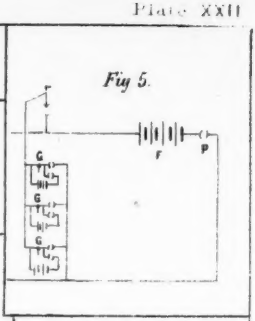


Fig. 5.

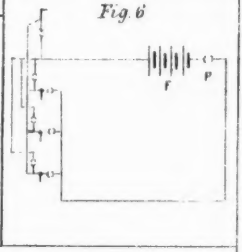


Fig. 6.

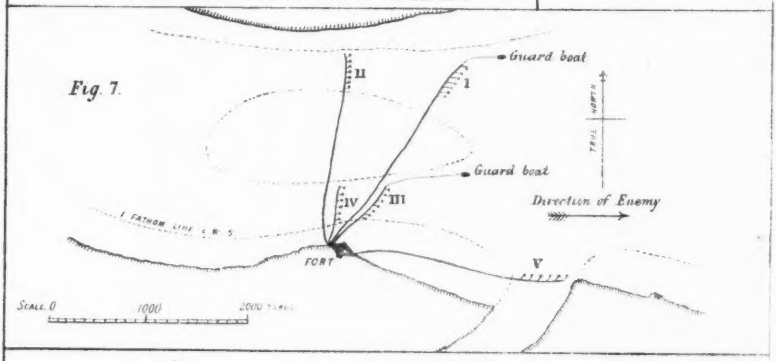


Fig. 7.

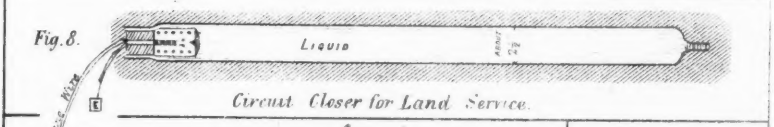


Fig. 8.

Circuit Closer for Land Service.

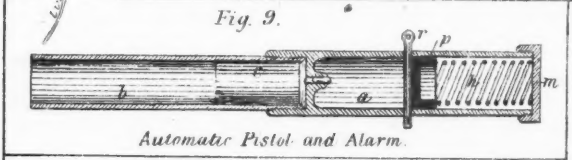


Fig. 9.

Automatic Pistol and Alarm.

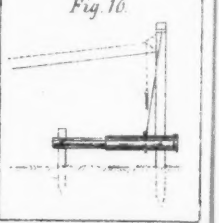


Fig. 10.

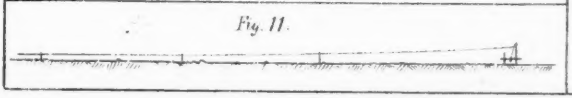


Fig. 11.

Harrison & Sons, Lith. 59 Martins Lane W.C.

Friday, March 14, 1884.

GENERAL SIR ORFEUR CAVENAGH, K.C.S.I., in the Chair.

AUTOMATIC ARTILLERY FIRE.

By Major BUCKNILL, R.E.

As a rule, inventors do not receive much encouragement in England; but this is an exceptional place, and this Institution may fairly be called the headquarters of a society which, among its numerous and useful purposes, gives protection and encouragement to naval and military inventors.

The subject on which I have the temerity to address you is headed *Automatic Artillery Fire.* As regards artillery fire, I profess to but scanty knowledge. The germ I wish to bring to your notice is described by the entire heading.

It consists essentially of an electrical arrangement, which provides accurate artillery fire at unseen objects during thick and foggy weather, or during absolute darkness.

The arrangement in its simplest possible form is shown on Fig. 1 (Plate XXII), and consists of a circuit-closer C connected with "earth" abroad, on the one hand, and with an insulated wire or cable W, on the other. This wire is led to a voltaic firing battery F and to an electric tube in the gun G to be fired: thence to a firing plug P, and to "earth" at home.

As soon as the circuit-closer is actuated, it is evident that, if the plug at P be inserted, the battery current will fire the gun.[1]

If, therefore, the circuit-closer has previously been so placed that the gun, howitzer, or mortar can be brought to bear upon that locality, and if this piece of artillery, hereinafter called the gun, has been previously so laid, it is evident that when the electric current flows and fires the gun, the body, whatever it be, which moves the circuit-closer will be hit by the projectile.

There are objections, however, to connecting the firing battery direct to a long line of insulated cable or wire which leads to a circuit-closer. To get over these objections, a small constant battery B,

[1] The firing current should not be less than $\frac{5}{9}$ ampère for each electric gun-tube of Woolwich pattern.

Fig. 2, is used, one pole being connected to "earth" at home, the other to an electro-magnet M. The "earth return" completes the outer circuit as soon as the circuit-closer is actuated, and a current then flows along the wire and through the electro-magnet, causing an armature A to be attracted. This frees a lever L, which falls into and becomes fixed in a jaw J, placed below to receive it.

The inner or firing circuit includes the firing battery F, a plug-hole P, the gun-tube G, and the opening just described, J L. If P be plugged, the firing circuit is closed by the fall of L into J, and the gun is fired automatically the moment that the circuit-closer is actuated.

It will often occur that the advance of an enemy will be possible over a wide front, when a number of circuit-closers would be required. In order to economize the insulated cable, the most costly portion of most electrical arrangements, a number of circuit-closers can be placed on a single cable, as shown on Fig. 3. If one of them gets out of order and gives continuous dead earth, the system would fail. To avoid this result, a wire fuze, consisting of a single fine wire, would be placed at the junction of each branch cable with the main cable. The disconnecting fuze for the outermost circuit-closer would be placed on the main cable just outside the branch to the next circuit-closer. This fuze would then act for the end circuit-closer with its branch cable as well as for the last piece of the main cable. This done, as soon as it became evident that a fault had occurred, it would only be necessary to connect the firing battery with the main cable in order to cut out the faulty branch and circuit-closer, leaving the remainder in good order. If, however, the fault still remained, it would show that the main cable was out of order.

Those who are conversant with submarine mining will note that the general arrangement is similar to that which has been employed both in this and other countries for electro-contact submarine mines, the chief difference being that in the arrangement I propose for artillery the electrical firing is done on the inner or local circuit: whereas in submarine mines the firing must be done on the outer or distant circuit.

The difference is important, and enables me to use the very simple electrical arrangements already indicated, and which have been laid aside in submarine mining, and replaced by more complicated systems on account (*inter alia*) of the technical difficulties which are entailed by firing on the outer circuit.

In the system I propose to adopt for automatic artillery fire, the circuit-closers which are on one cable would be placed on plan in straight lines converging on the gun, with which they would be connected.

In the case of a narrow channel enfiladed by the gun they would be placed in the centre of the channel. But usually the lines of circuit-closers would be placed across the channel, either directly or obliquely, as in Fig. 7.

By using a suitable firing battery a number of guns can be fired simultaneously by one firing battery on a local circuit, the gun-tubes

being arranged in multiple arc or in series, according to the voltaic battery employed. I prefer the former, in connection with a low resistance battery, as failures due to difference in the sensitivity of the gun-tubes are less likely to occur than in the system of firing in series by a battery with a large number of smaller cells.

There are areas of maximum fire effect in front of all forts and fortresses. In circular forts with equally spaced casemates these areas depend on the armament, the splay of the ports, and the extreme traverse of the guns.

In other forts the areas of maximum fire effect depend, in addition to the above, upon the direction of the principal faces. It frequently happens that an area of maximum fire effect is obtained along the capital of two of the principal faces, especially when the salient is obtuse. The shape of these areas on plan is usually that of a segmental ray.

Assuming that the channel to be defended by the guns gave positions favourable for the mooring of circuit-closers in the said rays of maximum fire effect, they would be moored there in preference to other positions, so as to economize the stores, and the labour of laying them, and their maintenance when laid.

When there are several single circuit-closers on separate cables, or when there are several distinct groups or lines of circuit-closers, which are connected with one fort or battery of guns, it is convenient so to arrange matters that a single firing battery (Fig. 4) and a single actuating battery will do for them all.

This can be arranged without difficulty. The cables W, W, W, &c., are each provided with an electro-magnet M, and the electro-magnets M, M, M, &c., are all connected with the actuating battery B. The jaws J, J, J, &c., are all connected with one pole of the firing battery F.

An instrument which is employed in our Submarine Mining Service, and which is called the shutter and signalling apparatus, has been specially designed for somewhat similar electrical actions. This apparatus has already been exhibited to the public, at the Crystal Palace, and by the kind permission of the Inspector-General of Fortifications (General Sir Andrew Clarke, K.C.B., &c.), I am permitted to show it now.

You will observe that the box contains seven electro-magnets, each of which is provided with two terminals, one (A) being connected with the axis of the armature; the other (B) with the axis of the shutter. One of these terminals is employed for firing mines by observation, and the signalling as well as the firing currents to the mine are conducted through the other terminal. The signalling current passes from the coils to the armature and thence by a platinized stud to the shutter or falling lever. The firing current passes from the firing bar holding the jaw, before mentioned, to the lever as soon as it falls into the jaws, the signalling current and the coils being cut out of the circuit by the fall of the shutter.

For automatic artillery fire, I recommend a modification, viz., to connect the cable (W) to the circuit-closer, or group of circuit-

closers on the left terminal, and the local circuit wire on the right terminal. Also to insulate the shutter or lever from the signalling circuit. The two circuits are thus kept entirely distinct, and a powerful signalling battery can be employed, without the slightest danger to sensitive gun-tubes or fuzes on the local or inner circuit. Moreover, a bad shutter connection, as it is called, cannot occur, this connection not being employed in my proposed arrangement.

The shutter apparatus of seven indices, one signalling battery—one firing battery,—and an apparatus for testing resistances, would complete the equipment necessary for an important fort containing a large number of guns. At night, or during fog, the guns would be fired by the enemy coming in contact with some or other of the circuit-closers arranged in seven groups in front of the guns.

The electrical arrangements from their extreme simplicity could not fail to act in the manner intended.

In each gun emplacement the firing battery lead, and the return wire of the local circuit to the firing bar of the shutter apparatus, would terminate in the two leads to the gun fuze, and a plug would be inserted in the firing lead. This plug would be under the custody of No. 1 of the gun detachment, who could thereby throw the gun out of circuit at any moment for any period, in order to carry out any desired change in the loading, elevation, or traverse of the gun. But this could only be done in this manner if the method of firing the guns on multiple arc were pursued. If they were arranged in an electrical series a shunt and switch would be required in each gun emplacement, before any single gun could be cut out independently.

If desired, power could readily be given to No. 1 in each gun emplacement to fire his gun independently, which might be useful if the enemy's vessel made herself conspicuous by a light, or by sparks from her funnel, or by other means.

This power could be given in two ways without altering the connections and wires required for automatic firing.

(1.) By bringing a wire from the other pole of the firing battery, and by placing a firing key and the gun fuze between the two firing battery leads; or (2) by placing a small firing battery in each gun emplacement, and connecting it through a firing key, or plug, to the two leads of the gun fuze. These are shown in Fig. 5.

I need not trouble you with any more electrical details. It was necessary to give them in order to prove that there are no technical difficulties, and that the proposals are simple and workable.

We will now pass to the more general considerations, after hearing which, I hope you will be able to pronounce in favour of their value.

I ask,—why should costly forts be practically silenced by fog or darkness, for, say, 12 hours out of every 24? Even during moonlight nights, guns cannot be aimed with accuracy and effect, nor can they prevent unarmoured vessels from running past powerful batteries at short range.

This was proved over and over again during the American War of Secession.

For instance, the Federals established five powerful shore batteries

on the right bank of the Mississippi below Tiptonville, in order to block the channel against the Confederates. Nevertheless,[1] "these batteries were passed twice, almost nightly by one or other of the Confederate gunboats . . . . vessels remodelled from river boats, ... with side-wheels and carrying their boilers and machinery on deck." "Bright moonlight nights were not excepted." . . . . "The gauntlet was run successfully at least thirty times in twenty-one nights."

Had some circuit-closers been placed in the channel and connected with the batteries electrically, a very different history would probably now exist.

I have been asked, why not employ electro-contact submarine mines where the circuit-closers are placed for the proposed automatic artillery fire; and is it not better to use a submarine mine, if a cable and a circuit-closer and electrical details are employed?

In reply, I would state that the arrangements proposed are not intended to supplant submarine mining in the smallest degree, but rather to assist in the protection of the mines by the artillery fire of a place.

For it is seldom necessary to place submarine mines in advance of the forts, and it is generally advisable to place them so that the guns protect them by sweeping the water in front of them with a heavy fire.

My object is to enable the guns to carry out this duty at all times.

At night it may be anticipated that an active enemy will creep in with a view of destroying the active and passive obstructions by grapnelling for the cables and cutting them, or by sweeping for the mines, or by countermining. These operations would be undertaken by boats; and comparatively light guns, primed in the manner I suggest, would deny such operations to an enemy, and would form a stronger defence than that which is obtained by the employment of small mines specially constructed to act against boats.

The difficulty with small mines for use against boats is due to the rise and fall of tide, and to the small draught of all boats; for the mines would often be either a-wash, or submerged to a depth greater than the draught of the boats. Moreover, as boat mines must necessarily be placed in advanced positions they are subjected to rough water, and being so close to the surface the waves act upon them with their full force.

The circuit-closers which are connected to guns with the view of repelling boat attacks need not be placed at so small a submersion as boat mines, for the creeping, sweeping, or countermining operations would cause them to signal, although the boats were some distance from them both vertically and horizontally.

The small mines in such situations and so submerged would, however, be useless; but the cone of dispersion from shrapnel or other shell fire is such that the gun covers a considerable area with the bullets of shrapnel or fragments of shell.

Shrapnel possesses a cone of dispersion with an apex of about 8°,

[1] *Vide* Scheliha's "Coast Defences."

and the best results are obtained when the time fuze bursts the shell about 50 or 100 yards short of the object. The angle of descent may roughly be stated at one and a half times the angle of elevation at ordinary ranges.

Thus a shrapnel shell at a range of 2,000 yards fired at say $3\frac{1}{2}°$ elevation would fall at about 5°, and would cover an elliptical area of considerable length, and about 70 yards at the greatest width.

Any boats on such an area would almost certainly sustain considerable damage, and what is, perhaps, more important, the effect of being thus hit with accuracy in the dark by guns at a distance, could not fail to be demoralizing to the crews and to the attacking forces generally.

Hence it appears that shrapnel would be very efficient against boats that are not provided with special contrivances in the nature of armour.

As regards larger mines it must be remembered that their action is self-destructive, and that a gap, or more strictly an area safe for the enemy, is produced by the explosion of every mine.

This is not the case with automatic artillery fire, for the arrangement is again ready for action as soon as the guns are reloaded and primed. I look upon this as a somewhat important advantage.

Again, there is always this difficulty with electro-contact mines. If they be primed for automatic firing they are peculiarly vulnerable to self-destruction, brought about by countermining operations. On the other hand, if the firing of electro-contact mines be delayed purposely, there is always the risk of the vessel so injuring the mine itself as to prevent its firing subsequently when required to do so.

With the automatically fired gun there is no such dilemma, and one can retard the firing without any fear of a missfire even when the circuit-closer has been damaged by the ship.

There is yet one other advantage in favour of the arrangement suggested for automatic artillery fire as compared with submarine mines. It is this: that whereas the latter must be moored so far apart that the explosion of one shall not cause the explosion or damage of the other mines in its vicinity that are not intended to go off simultaneously, the circuit-closers used for automatic artillery fire can be placed as close together as is considered desirable.

This comparison between automatic gun fire and submarine mines is only made in order to prove that the former is strong in one or two points where submarine mines are weak, and that consequently, inasmuch as submarine mines and other obstructions are now acknowleged to be indispensable for the perfect defence of a seaport, automatic gun fire becomes especially useful as a means for protecting them at a time when they are most open to the hostile operations of an enterprising enemy.

The method of attacking submarine mines has received so much attention, and has been so carefully perfected by the naval forces, both of this and other countries, that it is the more desirable to employ every means whereby such attacks may be defeated or rendered difficult.

This is the more necessary on account of the somewhat unexpected want of efficiency of the most powerful electric search lights under certain atmospheric conditions, especially fog and smoke, during calm weather: conditions of somewhat frequent occurrence in England.

There is no difficulty in relaying a gun on a circuit-closer in the dark with accuracy. Let us suppose that the channels shown on Fig. 7 are protected by a fort as shown, on which are mounted ten guns, four on each face, and two in a turret at the salient. A table would be drawn up for each gun, and each group of circuit-closers, on which would be recorded the vertical and horizontal angle for each gun when aimed on the central circuit-closer of each group, both at high and at low tide. These angles would be found by day by mooring a boat over the central circuit-closer of each group, and aiming at it with each gun; the height of the tide at the time being known corrections to high and low water could be calculated, and the resulting vertical angles recorded in the table, as on the accompanying example for Fig. 7 already alluded to.

The horizontal angles given in the table on the next page are given from a meridian passing through the centre of the turret.

In situations where the water is deep and the tidal currents of ebb and flow are strong, the alteration in the position in plan of the circuit-closers might be as much as 50 or 60 feet, and allowance for this tidal variation could be given in the training of the guns. If, however, the variation were not provided for, failure would not ensue, for the length of a ship may be taken at from 200 to 300 feet, or four times as much as the extreme scope of the circuit-closer above mentioned.

The scope of the circuit-closers could be entirely prevented by the use of double moorings, an arrangement which I have advocated for a long time.

Reverting to the fort already alluded to and shown on Fig. 7, the two main channels would each be crossed by two groups of circuit-closers in connection with the guns of the fort, and another group would be moored across the mouth of the small tributary also guarded by the fort.

The Groups I, II, III, IV are moored in the rays of maximum fire effect, and so that Nos. I and III are in the same alignment on the fort, as also are Nos. II and IV. The guns, therefore, can be altered from one group to another without training.

Groups I and II are placed in the example 1,200 yards apart, which a ship would take $3\frac{3}{4}$ minutes to traverse at a speed of 10 knots an hour. This gives time for the turret-guns to fire at Group I and to reload, and to be traversed on Group II before the ship arrives there.

But this could not be done in the southern channel where the groups are of necessity much nearer to each other.

Probably the best normal state of affairs in the fort would be to train Nos. 7 and 8 guns on Group II, Nos. 9 and 10 on Group IV, the turret-guns on Group I, Nos. 3 and 4 guns on Group III, and Nos. 1 and 2 guns on Group V.

Automatic Artillery Fire.

Gun, No. of.	Tide.	Angles for each gun on each group of circuit-closers.									
		Group I.		Group II.		Group III.		Group IV.		Group V.	
		Vertical.	Horizontal.	Vertical.	Horizontal.	Vertical.	Horizontal.	Vertical.	Horizontal.	Vertical.	Horizontal.
1	H	+4° 30′	344°	...	...	+0° 46′	344°	...	...	+3° 0′	292°
	L	+4° 26½′	344°	...	...	+0° 28′	344°	...	...	+2° 53	292°
2	H	+4° 30′	344°	...	...	+0° 46′	344°	...	...	+3° 0′	292°
	L	+4° 26½	344°	...	...	+0° 28′	344°	...	...	+2° 53′	292°
3	H	+4° 30′	344°	..	...	+0° 46′	344°	...	...	+3° 1′	292°
	L	+4° 26½	341°	...	...	+0° 28′	344°	...	...	+2° 53′	292°
4	H	+4° 30′	344°	...	...	+0° 46′	344°	...	...	+3° 1′	292°
	L	+4° 26½	344°	...	...	+0° 28′	344°	...	...	+2° 53′	292°
Turret (guns).	H	+4° 30′	344°	+4° 20′	30°	+0° 46	344°	+0° 40′	30°	+3° 1′	292°
	L	+4° 26¼′	344°	+4° 15¼′	30°	+0° 28′	341°	−0° 15′	30°	+2° 53	292°
7	H	...	...	+4° 20′	30°	...	...	+0° 40′	30°	...	...
	L	...	...	+4° 15½′	30°	...	...	−0° 18′	30°	...	...
8	H	...	...	+4° 20′	30°	...	...	+0° 40′	30°	...	...
	L	...	...	+4° 15½′	30°	...	...	−0° 18′	30°	...	...
9	H	...	...	+4° 20′	30°	...	...	+0° 40′	30°	...	...
	L	...	...	+4° 15¼′	30°	...	...	−0° 18′	30°	...	...
10	H	...	...	+4° 20′	30°	...	...	+0° 40′	30°	...	...
	L	...	...	+4° 15¼′	30°	...	...	−0° 18′	30°	...	...

Remarks.

Abbreviations.

R (horizontal)	=	right.
L ,,	=	left.
H (tide)	=	high.
L ,,	=	low.
+	=	elevation.
−	=	depression.

Ranges of central circuit-closer from fort in yards.

Group I	=	2,300.
,, II	=	2,200.
,, III	=	600.
,, IV	=	500.
,, V	=	1,800.

Rise and fall of tide from 10 to 12 feet.

In the defence of a harbour it would always be advisable to place guard boats well out to the front. Some of these boats should move about and act in the same manner as patrols in front of the outposts of an army; others of the boats should take up fixed positions and act as the picquets or advanced posts. These boats should certainly be able to communicate with the forts either by submarine telegraph or by visual signals.

The training and elevation of the guns, and the nature of the projectiles, could then be altered so as to provide the best defence according to the circumstances of the attack which would be signalled or telegraphed from the advanced boats. Suppose, for instance, in the diagram examples that a message were received from an advanced guard boat to the effect that some large vessels, not showing preconcerted lights, were approaching the northern channel. The loading of some of the guns would be rearranged, and the elevation requisite for the northern channel given to them.

Similarly if a message came saying that unknown boats were drifting up with the tide, sweeping operations might be anticipated; and should the guard boats of the defence be beaten back, an automatic fire of shrapnel would probably prevent the boats passing the circuit-closers and gaining the waters wherein are moored the submarine mines.

It should be especially noted that a boat exploding a grapnel successfully against one of the circuit-closer cables would thereby produce a bare end and an earth, whereby the signalling battery would act on the shutter apparatus and cause some of the guns to be fired.

As regards the stores necessary for automatic artillery fire from sea forts, I may observe that no expense would be incurred in this country for the under-water apparatus, there being a great superabundance of single electric cables in store, and a large number (some hundreds) of an old and obsolete electro-contact submarine mine, which would answer very well for the circuit-closers.

The shore instruments are few and inexpensive, one firing battery, one shutter apparatus, a few firing plugs, and some insulated wires, being all that would be required for a large fort.

I will now endeavour to show that the arrangement is applicable for land fortifications, as also for field service.

Fortifications erected for land defence are generally so situated with regard to the surrounding country, that the important points to the attack, such as positions for the attacking artillery, the probable lines of advance of troops, &c., can be foreseen with tolerable accuracy.

I would recommend that light insulated wires be carried underground from the fortifications to these points, and that they should there terminate in one or more small sunken circuit-closers. This should be a simple apparatus not likely to get out of order and actuated by pressure applied on the surface of the ground, such as a gun-wheel rolling over it, or the tread of a man's foot, or of a horse's hoof.

Moreover, it should be so made that it will not occasion any but the very slightest movement of the ground over it, which would cause its discovery.

I have designed such an apparatus, see Fig. 8. It consists of an outer tube made of some elastic or compressible material like india-rubber. This tube is filled with some liquid, and closed at one end. The other end terminates in an insulated plug through which the two wires are led, and are terminated in two bare ends separated by a small distance. The inner end of the plug is covered by a small inner tube filled with air. Inside this tube is placed a spiral spring resting on the end of the plug, and keeping the inner tube extended. The end of the inner tube furthest from the plug is provided with a metal bridge. The whole apparatus is buried a short distance below the surface, so that when any weight from a passing object is brought to bear upon the surface of the ground over it the liquid is compressed and the small inner tube collapses longitudinally, thus causing the metal bridge to come into contact and electrically connect the two bare ends.

The helical spring brings the apparatus back into its normal condition as soon as the weight is removed from the surface of the ground over it. Owing to the hydraulic principle involved, a very small motion of the ground occurs, and the enemy cannot therefore detect the presence of the apparatus. Moreover, the hydraulic principle enables me to use a small spring to bring the apparatus back into its normal state. Owing to the apparatus being entirely inclosed in the tube or bag, it is protected from injury and from dust, &c.

The spring may be flat and the details of the arrangement modified in numerous manners. Compressed air may be used instead of a metal spring, or an india-rubber spring acting from extension be employed instead of a metal spring acting from compression.

Crude instruments of the kind were used in the American War of Secession, when small land torpedoes were employed by the Confederates with considerable success, the Northern soldiers refusing to attack over ground so mined. Even a lot of small red flags with nothing below them had a similar effect.

Circuit-closers having been placed as described, the guns of the defence would be laid upon them, and could be fired or not as desired when any one of the said circuit-closers gave a contact or a number of contacts showing the passage of troops or guns over the place.[1]

The electrical arrangements would be precisely the same as in the case of sea forts, but a smaller number of circuit-closers would be required on each electric cable; one circuit-closer being as a rule sufficient. Thus a number of guns could be laid on one spot, and be fired by means of one electric cable.

[1] I have often thought that a sensitive telephone, or microphone, if placed in a small subterranean watertight box, might be of value if hidden under the centre of some important road, and connected by a wire with the fortress. Any unusual activity of the enemy would then be heard through a telephone in the fortress, and by placing two telephones 100 yards apart, and connecting them with the fortress by separate wires, the direction taken by the enemy's forces in the road would become evident.

In the arrangements for sea forts as well as land forts it would always be advisable to have two wires for each firing lead, such wires being separated as much as possible, so that the shot of an enemy cutting a wire may not cause a failure. This excellent rule is insisted upon in the Royal Navy for firing broadsides by electricity.

Before leaving this part of the subject sorties by night should be noticed. This form of attack can generally be predicted with considerable accuracy, both as regards the probable object of the attack and the route or routes by which the columns will advance.

It is, therefore, not a very difficult task to forestall the enemy in such enterprises, and to be prepared to meet him at critical points with rifle or artillery fire.

For the same reason the electrical arrangements for automatic artillery fire along the lines of approach can be made without difficulty, and as the ground would probably be in the hands of the investing forces, the enemy could not reconnoitre closely or examine the route or routes he intended to take before the actual advance is made.

We will now examine the openings which present themselves for the use of automatic fire in field operations, where it may often be of considerable value.

How frequently it occurs that a bridge, defile, or causeway should be forbidden to an enemy at night, although such a position may be so far beyond the line of outposts as to make it very difficult, if not impossible, to do so. Under such conditions it would seem possible to reel out some (say a mile of) field telegraph cable terminating at the said bridge or causeway in a land service circuit-closer placed under the ground; the other end of the line being led to a suitable position for a couple of guns, and being connected in continuous circuit through the electrical gun-tubes and a firing plug to a portable firing battery, carried on one of the limbers. In this way, if the guns were previously carefully laid on the bridge, at the proper elevation, as soon as an enemy attempted to cross, the circuit-closer would cause the fire of the distant guns, and the passage of the bridge or defile would be denied to the enemy except at a loss nearly equal to a passage in open daylight. For although some difficulty would be met with in relaying field guns in the dark at the proper elevation and direction, fair practice could probably be made if the direction were obtained by means of pickets covered with white luminous paint; and correct elevation is, I understand, obtainable in the dark by the use of certain gun-sights which have been for many years recommended by Captain L. K. Scott, R.E.

In the recent interesting lectures on "Night Attacks" delivered here by Captain R. F. Johnson, R.A.,[1] he pointed out that artillery on the side of the defence would always be very useful at short ranges, and for sweeping approaches and defiles of all sorts. I claim that by the employment of simple electrical appliances, artillery on the side of defence can often be rendered useful at long ranges, and especially for sweeping those more distant lines of approach which can be enfiladed but are entirely out of sight during the night.

[1] See Journal, No. CXXIII, p. 31, *et seq.*

Again, obstructions such as wire entanglements, abattis, &c., are now generally placed close to the line of resistance, as it is considered necessary to sweep them with as effective a fire as possible in case of an attack at night; but Captain Johnson made a remark in his lecture which apparently advocates the employment of obstacles at greater distances, "as they must cause delay in the advance, and may oblige the columns" of the attack "to swerve from their appointed routes, and wander into space."

The efficiency of such arrangements would, I submit, be increased by covering them with an artillery or machine-gun fire, the presence of the enemy at or near the obstacles being indicated by the action of simple electrical contrivances. In the case of wire entanglements it could easily be arranged that extra tension on certain advanced wires, or loss of tension from their being cut, would in either case produce an electrical current through an insulated wire led thereto from some point in or behind the line of resistance.

This leads me to the description of a little arrangement which I have designed quite recently, and which I call the automatic pistol and alarm. It consists of two or more pickets which support a short length, say 50 yards, of wire, the end picket being provided with a kind of pistol, fixed so as to enfilade the wire. The said pistol would be loaded with slugs, and would make excellent practice in the dark on the legs of men or horses which came in contact with the wire. This can hardly come under the head of automatic artillery fire; but being automatic pistol fire I hope that I am in order in noticing it here. Pistols going off automatically in the manner described would produce a considerable moral effect on attacking troops, and if plenty of them were used would be likely enough to produce a panic among any but the best soldiery. The pistol reports, moreover, would cause the defenders to be on the alert, as at Trichinopoly, where "some of the assailants fell into a pit; and their muskets going off alarmed the garrison."[1]

The automatic pistol[2] I recommend is extremely simple and cheap. It is composed of a barrel (*b*), Fig. 9, open at each end, one end chambered for a cartridge (*c*), loaded in any desired manner. A breech-piece (*a*) screws on this end, and carries the striker (*s*), by which the cap in the centre of the cartridge is ignited, as soon as the plunger (*p*) is driven forward by the spiral spring (*h*), on the pin or rod (*r*) being withdrawn by a lanyard fixed to the eye on the top of the rod. The plunger and spring are inserted from the rear end of the breech-piece subsequently closed by the screw cap (*m*).

Fig. 10 represents the manner in which the arrangement would be erected by being tied to two pickets, a string or wire being carried from the draw-pin to the top of the tallest picket and fixed there.

[1] Captain Johnson's lecture on "Night Attacks."

[2] The principle of this automatic pistol is not new—as arrangements of this kind are often employed for killing big game in India—and I saw something of the kind in a Frenchman's garden in a lonely place in Algeria. He said that he used it on account of the wild boars, but I fancy the Arabs (Kabyles) were in his thoughts also. Also Hendon's patent poacher's alarm is similar in principle, the pistol being placed vertically and driving a rocket or light ball into the air.

The cord or wire which is carried along the ground on pickets, as shown in Fig. 11, is connected to the picket wire a few inches below the top of the picket. In this manner, when the ground wire is stumbled against in the dark, the picket wire has a strain thrown upon it, the pin is withdrawn and the pistol goes off. The tall picket can be placed on the other side of the draw-pin, and an ordinary bell-crank or wheel be employed, but I prefer the arrangement shown.

The very essence and soul of nocturnal attacks being, in 99 cases out of 100, surprise, it follows that any automatic arrangement which supplements the eyes and ears of the sentries and patrols, and which, moreover, is likely to cause a panic in the attacking or reconnoitring parties of the enemy, cannot fail to be of value if it can be easily applied, and if it be of an inexpensive and portable character.

The question of portability is of course vital for all field service apparatus, and I, therefore, bring to your notice a new voltaic cell invented by M. Skirwanov, which is extremely powerful for a cell of such small dimensions and weight.

Messrs. Elliott Brothers (who sell the battery) inform me that it has the electromotive force of 1·6 volts, and a small cell only $2\frac{1}{2}'' \times 2\frac{1}{2}'' \times 0\frac{1}{2}''$ or thereabouts, gives a current of 3·2 ampères on one of Sir William Thomson's current meters. Its liquid resistance is said to be as low as 0·15 ohm per cell. It is by far the most portable battery ever made for giving powerful currents.

Two of these small cells will give a sufficient current to keep a 1 ampère star light going for one hour. The cell consists of a silver plate surrounded by silver chloride in a parchment paper bag, and this again enveloped by a U-shaped zinc plate in a solution of caustic potash, the whole being encased in an ebonite or gutta-percha cell hermetically sealed up.

Firing Batteries, Voltaic.

Description of battery.	No. of cells.	Dimensions—inches.			Weight lbs.	Resnce. ohm.	E.M.F.	Remarks.
		Length.	Breadth.	Depth.				
Naval—ship's battery for firing broadsides...	6	26	21	17	300	·07	1·5	Leclanché
Naval—boat battery for firing outriggers	10	19	17	12	118		1·5	,,
Naval—boat battery for firing countermines	3	10½	7	13	37		1·5	,,
Skirwanov's new cell ...	1	2½	¼	2½	A few ounces.	·15	1·6	Silver chloride and silver caustic potass and zinc
Military—for submarine mining	1	5¼	3	7	8	·2	1·5	Leclanché.

The table gives a comparison between it and the firing batteries already employed in our Services. Of course, portability is not

sought after in a ship, and the ship's battery is made very large in order to fire the guns on broadside in divided circuit.

Before concluding, I must ask you to allow me to read a few letters in reply to inquiries about automatic artillery fire which I made after hearing from Captain Gordon, R.N., late of H.M.S. "Vernon," that he thought something of the kind had been tried in the Navy.

14 | 2 | 84. From Captain J. Durnford, R.N.

"I am afraid I have neglected replying to your letter for a long time. I have searched for some authentic reports on the subject you name, but cannot drop across any among our papers, &c. It seems though to have been rather handed down by tradition, and I can't find out quite how."

17 | 2 | 84. From Captain W. E. Gordon, R.N.

"I fear I cannot give you anything like accurate dates, but so far as I remember, firing guns by circuit-closers was no new thing when I joined the 'Vernon' in 1879. I think it must have been in that year that in a night attack on 'Hecla' we used circuit-closers to fire alarms, and I think guns also, and I think we had them all round the ship.

"It was also, I think, in the same year that I remember a very complete plan for the night defence of a corvette ('Champion,' I think) being submitted to me by the gunner of that ship (I think his name was May), in which laying the guns all round the horizon and firing them by circuit-closers was a principal feature.

"I have, however, no doubt that Captain Durnford in the 'Vernon' could give you more accurate information, or Captain Singer now on the Great Gun Committee. You may, of course, make use of this information, such as it is, in any way you like, but it would, I think, be better to get something more accurate from 'Vernon,' as I am trusting solely to memory. I should not be surprised if there is mention of circuit-closers for firing guns in our torpedo manual, but I do not know for certain."

18 | 2 | 84. From Captain Morgan Singer, R.N.

"With respect to the query contained in your note of the 15th instant, I think I may safely say that the Navy have done nothing with respect to the automatic fire of guns by means of electric cables and circuit-closers. Every ship has gear sufficient to do it, and ample knowledge to enable them to make the necessary arrangements, but I doubt whether many men will see the necessity of acting in the manner such an arrangement would necessitate."

I have only to add that I quite concur in Captain Singer's opinion, that automatic artillery fire is not suited for employment for defensive purposes on ships, if for this reason only—that ships are moored generally in such a manner that they move about a good deal with alterations in the wind or in the tidal currents; and considering the length of a ship, and the amount of cable she would have out in waters of ordinary depth, it is obvious that the movement would be very considerable, and be such as to prohibit any hope of accurate automatic artillery fire.

The arrangements I propose are suitable only to a fixed platform, steady both horizontally and vertically.

The experimental trial of the arrangement for sea forts that I have had the honour of bringing to your notice could be carried out without any special contrivances or any special votes, as the stores are all in the Service, and the labour could be incorporated with the

annual exercises of the Royal Artillery and of the Royal Engineers' submarine miners. These trials would be conducted by day with blank cartridge, boats carrying on creeping operations and steamers attempting to run past the line of circuit-closers being fired at automatically with blank cartridge, and No. 1 of each gun stating what his gun was on at the time it fired. If successful the trial of the proposals which refer to land forts would probably be considered unnecessary, the action being similar and the speed of the objects less, but the continued efficiency of the special land service circuit-closer already referred to would require to be demonstrated by certain trials.

The success of the electrical arrangements proposed for field operations would depend on the rapidity and ease or otherwise with which they could be fixed, and the insulated wire laid out and reeled up. They would also depend on a portable voltaic battery being found which is efficient and will stand the knocking about of service. These matters can only be settled by actual trial.

The automatic pistol and alarm can be tried at Aldershot at any time as soon as permission is obtained.

No one rising to speak—

The CHAIRMAN said: As there appears to be no probability of a discussion upon this subject I will simply say a few words before we break up. There is no doubt that modern scientific discoveries and improvements have effected a very great revolution in the art of war. This revolution is not, as far as we are concerned as a nation, altogether an unmixed advantage, because although it adds to our strength when we come into collision with savage and barbarous foes, when we enter upon a campaign against civilized armies, by placing second and first rate soldiers more upon an equality, it certainly deprives us of the power which we formerly always possessed from the fact of our having perfect confidence in our men, of being able to decide a battle by coming to close quarters with our enemy and using cold steel. But this is now at an end. It is clear as we cannot stem the tide we must float with it, and consequently that we are bound to avail ourselves of every scientific discovery that is brought before us. It is perfectly possible that ere long automatic artillery fire may be utilized for the purpose of defending harbours, and even defiles and bridges, but at the same time as regards the latter we certainly ought not to relax our watchfulness over the bridge or defile that we are defending. Some of us here, perhaps, are familiar with a case which occurred in the Peninsula. The Spaniards had a bridge which they had mined, connecting the mine by a saucisson with the battery by which it was commanded, they were consequently somewhat off their guard. One moonlight night a French sapper clothed in grey, rolling a small powder-barrel covered with flannel before him, took advantage of the shadow of the parapet to reach a point beyond the mine, placed his barrel in the middle of the roadway and exploded it. The consequence was the connection with the mine was separated. The French passed over easily and took the battery. A similar occurrence might happen if we trusted the protection of a bridge or defile entirely to automatic artillery fire; still this is no reason why we should not make use of it if it can be proved to strengthen our means of defence. I am sure I am meeting your wishes in expressing to Major Bucknill our sincere thanks for the very interesting lecture which he has given us, and more especially for his description of his extremely ingenious earth circuit-closer and his automatic pistol.

Wednesday, June 11, 1884.

ADMIRAL SIR ARTHUR P. RYDER, K.C.B., Member of Council, in the Chair.

DISCUSSION ON THE SUBJECT OF THE NAVAL PRIZE ESSAY, VIZ.—

"ON AN OUTBREAK OF WAR, WHAT IS THE BEST ORGANIZATION FOR DISTRIBUTING THE PERSONNEL OF THE NAVY AND OF THE RESERVES AMONG THE AVAILABLE WAR VESSELS, AND AMONG A PROPORTION OF MERCHANT VESSELS AS AN AUXILIARY TO THE NAVY?"[1]

The CHAIRMAN: Ladies and Gentlemen,—The Naval Prize Essay that won the Gold Medal this year was written by Captain Charles Johnstone, late of Her Majesty's Ship "Dryad," a name now well known to us all, and whom I am glad to see here among us. The subject was: "On an outbreak of war, what is the best organization for distributing the *personnel* of the Navy and of the reserves among the available war vessels, and among a proportion of merchant vessels as an auxiliary to the Navy?" It has been thought convenient to furnish a list of different points in the essay proposed for discussion.[2] I wish you to understand that we are not discussing the essay, but the *subject* of the essay, and Captain Johnstone has kindly attended, in case any of his statements should require a little explanation. There are a few points which it is not proposed to discuss, but after abstracting those points, you have, I think, fifty-four left, so that there will be no want of food for digestion this afternoon. The rule is, that ten minutes are to be allowed for each speaker.

Admiral R. VESEY HAMILTON, C.B.: The points I intend to speak upon are principally those in which I differ from the essayists. The first is this: both essayists lay great stress upon the necessity of the Navy having to do with the stationary torpedo defences instead of the Royal Engineers. I differ from them on that point *in toto*. The Navy is an aggressive force, and it is not our place to be confined to the permanent defence of the country: that is for our brethren of the Army. I think we might just as well man the Spithead Forts with seamen. If we did as they do in France—put the whole defence of the seaports under the Port Admirals, which we are not likely to do, it would be a different matter. England has made its name by aggressive, not by defensive naval war. To go back to the days of Elizabeth, what staved off the Spanish Armada for a couple of years? Our singeing the "Don's whiskers in his own port," when the Navy, boldly attacking them in their own waters, burnt a large naval force at Cadiz; also Blake at Teneriffe. Again, take the attacks we made on the French fleets at Cherbourg and La Hogue under Rooke; go to a later period, the Basque Roads. In all these cases the Navy were on the offensive. We have occasionally had defensive wars in England, and they do not redound to our credit. I allude to the Dutch sailing up the Medway and

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[1] The essays of Captains Johnstone and Cleveland appeared in No. CXXIII of the Journal.

[2] The list is too long for publication.—ED.

destroying our fleets off Chatham. The only two invasions of England that succeeded were those by William the Conqueror and by William of Orange. In both cases the English fleets were on the defensive. No doubt the results turned out to the advantage of the country, but that is neither here nor there. The first thing on the outbreak of war is, that we should take the offensive (and not act on the defensive), for which every available seaman will be required. With regard to the Royal Engineers for torpedo defence, I have seen a good deal of that work, and I think those trials in which the Navy attacked, and the Royal Engineers defended, were of the utmost good to both Services. They developed the weak points and excited a great deal of emulation, which would not have been the case if the attack and defence had been by the Royal Engineers or the Navy. There is one point in which I differ from the Treasury Minutes. The Royal Engineers should be entirely on their own hook, even for boats. We have seen quite enough of the evils of the dual system in Egypt, and also in our supply of naval stores by the War Office. When war is going on, it is very certain that our whole efforts must be exerted on behalf of the naval service. We shall have neither boats nor men to spare. There is another point in which I differ from the Gold Medal essayist. He considers that Newfoundland, amongst other Colonies, may be a source of supply for seamen for the Navy. I was four years on that station, and was well known. Our doctors exerted themselves greatly on behalf of the resident populations when there was small-pox about, yet I only shipped one man. We went to the coast of Labrador. I returned to Newfoundland, and that man deserted at the first opportunity. Harvey's History of Newfoundland tells us that it has not been a source of supply to our Navy, but quite the contrary. Our men have deserted right and left and have very rarely been captured. I do not know so much with regard to the other Colonies, but on that point I speak from personal experience. Defence of their own shore is a question I give no opinion on; if they are paid they will do it. There is another point on which I differ. The essayist assumed that all wars will be quickly decided. I do not believe that. The Prussian and Austrian and the Franco-German wars were peculiar, but if we go back to the beginning of the century, we find that in 1805 the Austrians were annihilated, and in 1806 the Prussians were annihilated far more quickly than the Austrians by the Prussians in 1866, or the French in the succeeding war of 1870. In 1805, the French crossed the Rhine on September 20th. Ulm was taken October 20th, which practically annihilated Austria. Austerlitz was fought December 1st, and that war was ended. In 1806 the Prussian war commenced 1st October; Jena was fought October 14th, and Berlin was occupied October 25th. Considering that those people had to do everything with their legs, for there were no railways then, those campaigns were decided far more rapidly than those of the present day. In both those cases one side possessed exceptional advantages, having the best General and the best organization. If both parties had had equal Generals and equal organizations those wars would have been as indecisive as ever. The essayists appear to think that the force we have now would be quite sufficient. Now that is a point in which I also differ from them. Having no present experience we must go back to history previous to the Russian war. From 1850 to 1853 there were 39,000 seamen and marines voted for the Navy, and that may be considered the peace establishment for that period. In 1853-54 the number was 45,500, in 1854–55 it was 58,500, in 1855–56 it was 70,000, and in 1856-57, 76,000 were voted. That is a very rapid increase, and it is to be remembered we were then at war with the most unenterprising naval Power we ever had to encounter; and not only that, but we were aided by the French, which added at least 40 per cent. to our force. In 1814 we had 147,000 seamen and marines, from a population of 18,000,000; therefore I apprehend we shall have very greatly to increase the force in case of war. With regard to the United States Navy: they had 5,000 men and 55 vessels in 1860, and in 1864 they had increased to 57,000 men and nearly 700 vessels, and yet they had none too many to prevent blockade runners occasionally breaking in, and even coming out of Wilmington. In 1792 we commenced the war with 153 line-of-battle ships (efficient and non-efficient) against 86 French, probably the same, but not mentioned. On the 1st June, 1794, we had only 25 English against 26 French. In 1795, Admiral Hotham had only 13 against 15 French. At St. Vincent, 1797, there were only 15 English against 27 Spanish. At the Nile the numbers

were equal, but while the English were all seventy-four's many of the French were from 130 to 80 gun ships. At Trafalgar we only had 27 to 33, so that with all this large force of sail of the line, we had so much to defend that we were never equal to the French at the point of attack. In those days we were self-supporting; we did not depend on abroad for food supplies; and even in 1814, nine years after Trafalgar, Sir Edward Pellew had only 15 sail of the line to blockade a French force of 23 at Toulon although we had 113 in commission; therefore I think in that respect both the essayists are wrong in assuming that we shall not have to increase our force very greatly. With regard to the number of Officers employed, I see the Gold Medallist has said that the number of Captains required would be 125. In the Russian war we employed 142, according to the Navy List, December, 1855. He says 208 Commanders are required; in the Russian war we employed 136. He says 795 Lieutenants will be required; in the Russian war we employed 716. He says the number of Navigating Officers required is 208; we employed 237. That, as I said before, was when our peace establishment was 39,000 men; now it is 60,000. Therefore I think we ought to prepare for a very rapid increase of our naval forces on the outbreak of war.[1]

Captain the Hon. E. FREMANTLE, R.N., C.B.: With due deference to Admiral Hamilton, whatever may take place in the future after a war which has lasted two or three years, I am inclined to congratulate the country upon the numbers of the reserves and of the active Navy being such as will be satisfactory to the whole nation. I see that one of the essayists puts it as 4,000 in excess of what is wanted. Captain Johnstone says 64,000 are required, and 68,000 are available; while Captain Cleveland puts the figures at 60,000 required and 72,000 available. It is a remarkable coincidence that the two Officers have gone so near as to the number available at the outbreak of war. I wish particularly to touch upon that. It is obvious that there are some difficulties, as people have found before now, in manipulating a surplus, but there are very much greater difficulties in dealing with a deficiency, and in this case I venture to think, as regards the outbreak of war at all events, we are dealing with a surplus. We may consider, then, that the old problem of manning the Navy is solved, and as one of the essayists put it, the difficulty is now not men but ships. I wish particularly to qualify that remark at the risk of repetition, by saying I am only dealing with the outbreak of war, and that is the thing which the essayists profess to deal with. I am perfectly aware of what was done by the Americans after their war broke out. They began with an absurdly small force, and gradually succeeded in increasing it to one equivalent to what we have at present. I think there are weaknesses in the force, although the number altogether is sufficient. The great weakness is in the engine-room staff. That has scarcely had sufficient stress laid upon it. I know Captain Cleveland mentioned it, and I think Captain Johnstone observed that there were scarcely sufficient, but in Captain Johnstone's essay I did not see it quite so clearly separated from the other points as in Captain Cleveland's essay. Now the only remedy for that is, I think, to encourage the stokers to enter more than they do in the Coastguard. I have served in the Coastguard myself, and I know that, as a rule, Divisional Officers do not care to have stokers placed in the Coastguard who are not as good seamen, and not so useful in handling boats as the remainder of the men; but when the Reserve ships are called out we are very anxious to get what stokers we can from the Coastguard, and the number of them is insufficient. In one of the essays—I think, in both of them—there is almost a preference shown for the Second Class Reserve men over the First Class Reserve. I do not at all differ from the policy of bringing the number of the Second Class Volunteers (to use the proper phrase) up to 10,000

[1] I have no objection to the Stationary Torpedo Force being watermen, &c., from the locality, but I object to a single man from the Navy proper being diverted from sea-going ships for that work. In the Russian war I was First Lieutenant of a ship fitted out nine months after war commenced, and we had not one man even from the "Excellent" to assist the gunner in drilling our raw levies, so rapidly were our drill ships cleared of instructors. Moreover, I think the Admiralty's time will be fully occupied with the sea fleets and should have nothing to say to stationary defence.

and decreasing the First Class, which only amount to a little over 11,000, to the same number; but I do object to continuing to enhance the value of the Second Class Volunteers at the expense of the First Class. It is quite true that they have certain distinct advantages. We know where they are living; they are generally close to their homes; they do not go far to sea in their fishing boats, and we can get at them. When we have said that, we have said everything that is to be said in their favour. They are a fine race of hardy seamen; they are accustomed to go to sea in their herring boats, especially those of Scotland, but their idea of going to sea is to fish from large boats, to wear long boots and numerous jerseys, and I venture to say that those are not exactly the men we want for smart and active seamen. In addition to this, in Scotland at all events, a great many of them speak Gaelic and not English, and that would be a very decided objection to men serving on board a British man-of-war. I should think there might be some improvement in their organization. As far as I understand, there is no special organization as regards which numbers shall be called out first; in fact I believe they are not arranged in sections, but I think it was proposed by Captain Johnstone that they should be in sections. All I can say is, there would be a very great advantage in their being in sections. You can at least call out a section: if that does not furnish enough men you can call out a second and so on, and you would not need to call out all the Reserves at once, and when you want only 2,000, find that you have got 11,000. I should like also to make a remark about the Coastguardsmen. It seems to me important that these very superior old seamen should be properly distributed amongst the men-of-war. I am quite aware that there is very great difficulty in doing that, but at the same time it is a point that ought to be borne in mind. I think all the new commissioned ships should have their petty officers from the Coastguard, because many of the Coastguard, although extremely good seamen, are a little uncomfortable at having to go too high aloft, and at their age they are naturally not so capable of being top-gallant yard men as younger men. That is a problem I have not seen sufficiently considered in the essays, but I am not myself prepared with a solution, except that I would suggest that, in case of war, a certain portion of them should be at once sent to every foreign station where it may be conveniently done, and without danger. I remark that there is a little difference among the essayists about the Marine servants. Under "Non-combatants" I see, whereas Captain Johnstone is very much inclined to rely on non-combatants, and thinks that we ought to take away the Marine servants from positions for which non-combatants would be available, Captain Cleveland appears to consider that it would be very much better if we had more combatants and less non-combatants. I venture to think that Captain Cleveland's is the correct view. It is right that we should again and again point out how necessary it is that we should have a larger force of combatants and a smaller force of non-combatants on board Her Majesty's ships. It is scarcely sufficiently noted that we deal with non-combatants in a different way from that in which they are dealt with in the Army or in foreign Services. For instance, instead of catching a stoker and guaranteeing that he shall know nothing except how to stoke, that he shall know nothing whatever about a gun, a rifle, or a cutlass, it appears to me that we ought to do the reverse: we ought to put him through a good course of drill, and having made him a sailor to a certain extent, we should then put him in the stokehole. This should also be the case, I think, with all so-called non-combatants on board ship. They should all be put through a course of drill first. I have dealt first of all with the men as, I think, the most important part, but Captain Johnstone has given us elaborate statistics as regards the Officers. I confess that I think the most important part is the men. In this country we are fortunately so situated that we have a very large class of gentlemen who are fond of the sea, and I think we have seldom had any difficulty as to the question of Officers in England. That is a great advantage which we possess over all foreign nations. I suppose the Americans are very much like ourselves in that respect. I recollect that some years ago, just after the close of the American war, I had occasion to go on board an American Flagship at Rio. They were furling sails at the time, and the American Admiral saw me look up the hatchway. There was a good deal of singing out going on, and he said, "There is a good deal of noise going on there." I said, "They are furling

sails, I think." He said, "The fact is I will tell you the history of that man: he is our First Lieutenant, and a very short time ago he came into our Navy as a Surgeon; he distinguished himself, and had some knowledge of the sea, and he is now First Lieutenant." I quote that to show the adaptability of the race. He was of the same race as ourselves, and had adapted himself to the circumstances, and in a very short time had risen from the position of Surgeon to that of Executive officer, and seemed to do his duties very well, although, perhaps, with not the same knowledge of drill as those who had been brought up to the trade. I also think (begging the essayists' pardon) that it is a mistake to deal so entirely separately with the navigating class. I thought that for good or evil we had changed that, and that every Officer on board ship was to be distinctly a combatant. I certainly think that the navigating class was a mistake. I am quite aware of the very large number of estimable and able men who perform navigating duties, but, at the same time, I think they ought to be merged in the executive, and under those circumstances I think it is a pity in an essay of this sort to have placed the navigating class so prominently forward. I think Captain Johnstone's remarks about engineers are extremely good, and I hope something in the direction he indicates is being done in the extension of the valuable corps of engine-room artificers. I think also if the Marine Officers would come forward in the right spirit, more work would be found for which they were available. In the old war, according to James' Naval History, there were very frequent cases of "cutting out" expeditions, when boats were entrusted to pursers and others who were not regular combatants. They volunteered for it, and very often did it very well; and I think if Marine Officers came forward in the right spirit, and Naval Officers met them in the right spirit, they might very often do more executive duties than they do at present. It was suggested by one of the essayists that they might be placed in charge of a day watch. I will not detain you any longer, but I should like to call your attention to the many interesting suggestions made by Captain Cleveland at the end of his essay. It is a little beside the question, but I certainly agree with him that the time has come when we ought to get rid of the separate gunnery examinations and the gunnery course of seamen gunners. I think all our seamen ought to be so educated in gunnery that we could get rid of the seamen gunners, although we might have some of the best men as instructors. That is a very valuable suggestion, coming from a man like Captain Cleveland, who has had special opportunities of judging of the subject.

Admiral SELWYN: Ten minutes is a very short time in which to deal with this great number of subjects, but there are some broad points which I may speak of at least in order to record my opinion on the subject. With regard to compulsory service, we can only say in broad terms that at the very lowest it must be in the future exactly what it has been in the past. Whether it would not be wise to give some training for the compulsory service which must take place during a war dangerous to the best interests of this country, I must leave to those who guide those matters to decide. I can see no difficulty whatever in getting the amount of training necessary if it is done in the right way and locally. I do not believe at all in getting people who know nothing but their own locality to take the place of those who must be trained in the Navy to the Naval Service. This country ought not to make the mistake of supposing that for a less sum of money it can by any means get equally well-trained forces. The tendency to-day is always to go for substitutes for the real thing, and to avoid by all means the question of the real thing, because it is supposed to be at present more expensive, although there is not a single one of all those who advocate that course of action who would not distinctly state, if asked, that he knew it was the most expensive way in the long run. There is a want of courage of their convictions somewhere among those who ought to guide these things. Whether the force of ships will be as assumed or not in future, I think it is very difficult to say, because the force of ships is calculated on the grounds of so many tons being built each year, and of ships requiring so much repairs before being put on active service. War is capable of breaking out in so short a time that I doubt whether anybody can tell what force could be put to sea immediately in such a case. I do not believe in the lists. I have seen them put in such a way as admitted of no answer but that they were not really effective vessels. All that one

can say is, that there ought to be a force sufficient to remove far from us any idea of failure or mistake when a war comes. With regard to a postal staff and the arrangement of the telegraph service, I think you might as well talk in the present day of going about without eyes or ears as without a proper staff for those subjects. Trained men we must have, and the sooner that is recognized as one of the necessities of the day, the better we shall be served in war. With regard to the number of pensioners to be brought into active service, what do pensioners become after eight or ten years' absence from the Navy? Do they know anything about the modern training? Even those called Artillery Volunteers, are they acquainted with the modern requirements up to to-day? Are they fit to put on board ship and to rely on except as hands? For the time, no doubt, they would be active hands, and would very quickly acquire some of their old knowledge, but a certain time would elapse before that knowledge would be acquired, and, meanwhile, we should have to do without some of the services which we are unjustly expecting to get from them. With regard to an efficient corps for coast torpedo work, I have recently had my attention drawn to some very efficient plans for the defence of our ports by electric torpedoes. I am sure that training our sailors at each port, under proper Officers, in the use of all these modern machines of war would be the true means of providing our local defences. At the same time I would not allow for an instant any idea of local defence being substituted for that which Admiral Hamilton has so well pointed out is the old line of offensive preparation providing for defence at home. Strength for offence is the best defence. How the Colonies might be called upon to provide for their own defence, I do not know. They are very rapidly adopting ideas which I think have been mooted in this Institution for a long while. They seem to value them much more than our own authorities do. I believe that they would defend themselves with the pluck of Englishmen, and they will apparently have much better means of defence than we have. As for the possibility of training natives, not of British blood, for work in coast defence, I have always thought we have a great many of them who would no doubt come forward again, as has been the case before, and they should be encouraged whenever they can be properly employed. As for the formation of a Reserve Corps of retired Officers, I do not think there is any necessity for such formation, because I have no doubt that every retired Officer, even if he were four score years and ten, would think he was ready to serve, and would certainly ask to serve in case of serious war. With regard to the establishment of a Coast Defence Corps and Sea Militia Force, I do not know what a Sea Militia Force is. I suppose sailors are sailors when they go to sea. If it is meant to ask whether the whole of our Mercantile Marine seamen can be usefully trained for helping the Navy, then I say I should like to know first of what nationality those seamen are; and secondly, how much they could know about the modern practice on board a man-of-war. As to the *personnel* of the Navy, it has ever been my wish that we could be induced in this country to imitate that which has resulted so well in the French Navy, which is never deficient, because it really has in its Mercantile Marine a force of young Officers who have been trained in the Navy, who have had at least from four to six years in the Navy, and do know a great deal about it. It has improved the Merchant Service very much. There is always a trained staff of young Officers available from the French Mercantile Marine. It is of no use whatever to have a man who writes certain letters after his name, but knows no more about the duties those letters are supposed to entail than about flying in the air. How a gentleman who has passed his mercantile experience at sea and gone on shore retired, is to come in as a young Lieutenant, or Officer, I do not know. Then with regard to the possibility of enabling merchant ships to defend themselves: we all know if it is a question of guns and coal defence as against an ironclad, it is perfect nonsense talking about it. You can instruct them in the use of torpedoes, and they would be very formidable, going seventeen or eighteen knots an hour, for a running fight, but I do not think anything else is worth talking about. I may say one thing more, which is this, that I hope to solve the question of stokers in the Navy by entirely doing away with them. We learn that no steamer on the Caspian to-day has any stokers on board. They burn liquid fuel. The engineer lights the fires when the steamer leaves the port, and never looks at the fire again until she reaches her destination.

Captain J. C. R. Colomb, late R.M.A.: There are just two or three points on which I should much like to offer a few observations. In the first place I would say that the essays which appear in the Journal for this month are pre-eminently useful and practical, and although I think that there is not in them a sufficient recognition of the practical value of the power of expansion in organization, I also see plainly that to have dealt with that they would rather have gone beyond the limits of their subject. I say that because I do not wish it to be understood for one minute that I consider our naval precautions are in any degree adequate to the requirements of this Empire. I agree with Captain Fremantle that we have sufficient men for the ships we have got, but the real point is, have we enough ships? I think that the question of merchant steamers has had a tendency to make the country believe that by giving them some additional local means of defence of their own, we can count upon them as a means of, in a hurry, supplementing deficiencies of our naval force. As I have written and spoken on the subject of armed merchant steamers, that is a position I, for one, must entirely disagree with; and when I come to the details for applying that principle, I must say I see many reasons for protesting against it, and I think it would be unworkable in practice. I see in one essay that it is proposed to take up 100 chartered ships, that is, to take 100 of your best and fastest steamers away from your carrying trade. Now the consideration of the quarter in which war breaks out will very materially affect the position of our Mercantile Marine. If you have a war with France, the trade between England and France naturally ceases, but it does not throw out of gear one single mercantile ship that, however armed, would be of the slightest use whatever as an auxiliary to our Navy. If, on the other hand, you take the question of war with the United States, the whole position is altered, because then the ships best adapted for auxiliaries to our fleet would be thrown out of gear. In any case, the best merchant steamers—which are the only ones you can contemplate using as auxiliaries—are those which are keeping up your communications with your Colonies, and as your Colonies grow, so these mercantile steamers—employed on that work—will increase in number and become more adaptable, by reason of speed and size, as independent auxiliaries to the Navy. I do not mean taking them away from their ordinary vocations, and attaching them as war auxiliaries to the fleet; but I mean that with their great speed and power you can give them sufficient teeth to bite with, and then make them independent of protection by your war fleet. Their proper avocations will of course in war still be as in peace—the keeping up the communications of our Empire. With regard to the establishment of a Coast Defence Corps, and a Sea Militia Force, I maintain that when you have boiled down the whole question of your naval defence it does resolve itself into two lines, one the line you push forward on the high seas, and off the enemy's coast. That is the first principle of your naval defence. But I think it is impossible not to admit that, subsidiary and supplemental to that line, you do want local means of harbour defence, which become your internal line of sea defence; and the true principle of organization is to make your second line as far as possible, not the actual reserve for your first line so much as the organizer of that reserve, the collector and recruiter for it; and I think there is a great deal in the question of a local Marine Militia Force, if you treat it in that manner as a necessary subsidiary line to your sea line, and not as any real security in a national naval sense. One word more with regard to the Colonies. I must differ from my friend Admiral Hamilton. Because he on one occasion enlisted a man at Newfoundland, and the man ran away, he does not see the necessity of doing more than we are doing—which by the way is nothing at all—towards drawing to the Navy that strength which is growing in our Colonies. My own belief is, that is the most important question of all when you come to deal with the question of men, and I think it is one which is much easier to solve than most people think. It wants moderate practical help and reasonable sympathy from the home Government. Why say Canada can do nothing with her seamen for a British war navy? Are not these seamen Englishmen? Is not Canada the fourth great carrying Power of the world by herself, and how can you persuade me that there is no source of British naval war strength in Canada? It is simply a question of organization; and if there is one thing I am more pleased with than another in these essays, it is to see, for the first time in the history of this Institution, both the essayists recognize the coming

great power and rapidly developing resources of Greater Britain, and the absolute necessity, considering their common interests with us, for developing with a common purpose their naval war power as a joint means of maintaining the supremacy of the sea, which is as necessary to them as it is to us.

Admiral Boys: The discussion has brought out one or two points on which I may be allowed to offer some remarks. The gist of the essay is contained in a few words Captain Johnstone has written, when he says that on the outbreak of war, "Britain must stand or fall by the force it has immediately at command." I think that is perfectly true, and the whole of our system of reserves should be based upon it. I would observe with regard to something Admiral Hamilton said about torpedo defences that, as far as I know, and I had something to do with it, the history of the present system of torpedo defences is this: it was originally intended that the Navy should take up the torpedo defences of our home ports, and when this was first mooted we had not the scientific knowledge which, thanks to the establishment of the "Vernon" we have now, nor had we the means or prospects of getting the men required for the duty. It was a very difficult question, and it was decided that the Royal Engineers should take it up, and be assisted by the boats and men from the fleet for the sea work. That was tried in practice at Malta, Sheerness, and Cork, and was found not to answer. When the time for drill came on, there were many difficulties; the men and boats were not always available at the right time, and from the divided responsibility the system did not work. Then it was the proposal of an Engineer Officer, that they should take it entirely, hiring men locally for completing boats' crews, &c., and I think now the Minute stands this way: that the Engineers undertake the whole of the defences, with the exception that the Admiralty find the boats and lighters, but do not man them. I may be wrong, and perhaps Admiral Hamilton has later information. With regard to the reserves on the outbreak of war, I think it is satisfactory to find that both the essayists, who must have had means of discovering what the facts are, and have gone considerably into detail, agree on this point. It appears that the supply and demand would be nearly balanced on the outbreak of war. That is so far satisfactory, but there is no provision made for any waste, and if a naval war should be extended beyond a few months, I am afraid there would be very little to fall back upon in the shape of reserves. We must remember that during war there is very little training; there is little or no training in gunnery ships; their work would practically cease, as the instructors and men could not be spared to remain in harbour ships for the considerable time which is necessary for the drills to make efficient gunners; therefore, I think our reserves are not quite sufficient. Then with regard to the defence of the home ports: there is one class of men whom both the essayists have alluded to, and Captain Johnstone has recommended that they should be encouraged, I mean the Royal Naval Artillery Volunteers. Among the inhabitants of our island, especially on the coast, there is a body of men, from gentlemen downwards, who, if not actually sea-faring, are sea-going, always cruizing about in yachts, and boats, &c., and who would give their services willingly. I believe out of them you could raise an efficient corps for manning defence ships and gunboats, and with very little encouragement you would get a very good set of men. But they are not getting that encouragement, and in fact I think the authorities do not encourage them at all. It is quite true some of them may be barbers, pastry-cooks, &c.; and suppose they are, you do not want seamen, you want men to work a gun on board a ship or a gunboat, and any intelligent man might learn to do that in the course of a few months if you give him the opportunity and let him go outside a port occasionally to get his sea legs. I do not think our Lieutenants' List is anything like what it should be. It will be necessary to put our Lieutenants and Sub-Lieutenants in command of the numerous gunboats that must spring up around our coast for protecting our harbours in time of war, and I do not think the number of our Sub-Lieutenants and young Lieutenants is by any means sufficient. With regard to the arming of merchant vessels, Admiral Selwyn appears to think they are intended to fight regular men-of-war. That is not what I consider to be the intention. They are simply to be armed for their own defence, and to engage vessels of their own class, which, I believe, English vessels are fully equal to. Captain Fremantle made a remark about seamen gunners, and in the essay also the idea appears to be to

abolish that class. I do not understand the proposal. (Captain FREMANTLE: Every one should be a seaman gunner.) Undoubtedly every one should be a seaman gunner, but it is impossible; you cannot train all our men to be seamen gunners. It is proposed to abolish them, and to establish captains of turrets and captains of guns. That is merely an alteration in name which I do not see the necessity for. All seamen cannot learn what is required of a seaman gunner. He should be a man of superior attainments, who can be put on board an ordinary vessel, and with a few men collected round him, can soon drill them into a gun's crew. The term "seaman gunner" has been in use fifty years, and has answered very well. Let him retain the name and continue to do the duty which includes that of captain of turrets, captain of guns, and all other duties connected with guns afloat.

Captain CURTIS, R.N.: Admiral Boys, referring to the Royal Naval Artillery Volunteers, said that it was not necessary they should be sailors, but I think it is necessary that they should know how to make a rope fast to a buoy in bringing up a gunboat, or make a tow-rope fast, "timber-hitch," and so on. I happened to be at the Windsor Review, and saw them march well, but I noticed their knife-lanyards, and I asked one of them if he knew how to make a bowline knot, and his answer was "They do not teach us knots." Now knots are very simple things, also useful. I was once in a cutter, and an Irish fisherman had to make fast the hawser to check the ship, previous to taking in the moorings. The ship carried her weigh about 2½ knots, and she brought the strain on before he secured the end with spun yarn. He stuck to his work, and went down with the buoy and made it secure, otherwise the ship would have gone ashore near the quarantine lazaret in Malta Harbour. The word "compulsory service" is rather offensive in our days. I think you may read the word "patriotism" in two ways, what a man does for his country and what his country does for him. What scares a great many young fellows, or rather their sweethearts and wives, and prevents them going to fight for their country, is that there will be no provision made for their wives if they are killed in action. The wife of every man who is killed in action, or who receives a wound, should have some compensation, and the children should be educated until they are fit to get their living. One point which is of great importance is the recruiting of our sailors. I have mentioned this point more than once in this Institution. There are boys who are naturally sailors from instinct or habit. You may see a boy at Twickenham jump into a boat and take a pair of sculls, or fisher-lads sculling their boats in the Pool. Mr. Reed, Chief Officer of the Coastguard, was in a fishing-smack when he was ten years old, and went into the Navy when he was about thirteen. It so happened on one occasion that the chief boatman, who had been rated coxswain of the launch, got adrift in a boat and lost one of the oars; but Mr. Reed stripped, went after the boat, and sculled it back as the man was drifting helpless to sea. Now if the boatman had been an ordinary merchant-boy he would have put the oar over the quarter or stern and sculled back. Those are things which very few seamen in the Navy have an opportunity of learning. A cutter is called away, and he goes away, but if a boat gets adrift from the boom, he cannot scull it back. The men should be well paid for their services, and then there would not be much complaint about getting them. Some years ago, after the great war, Naval Lieutenants and Commanders were more frequently employed in the Coastguard, but that has been done away with, in a measure. I happen to have been an Officer in the Coastguard. There are always people trying to encroach on public rights, and the chief boatmen and chief Officers are not the class of people to contend with the gentry. I take it that Officers should be there to look after flotsam and jetsam and *public rights*. The chief boatman has not, as a rule, the moral courage to do so. We should have no half-pay Officers. There should be a roster, as Captain Johnstone suggests, and those Officers may go with two-thirds pay, and one-third of that time they should be employed in the dockyards, or in assisting the reserves, or in learning new drills, or torpedo exercises, &c. The question of merchant ships fighting is a very serious one, because, if you are in a man-of-war, and a merchant ship fires at you and kills ten or twelve men, and you ultimately catch her, you will rather be inclined to have no mercy on her. In former wars there used to be a point raised whether

a very inferior man-of-war ship should defend herself. I should say the merchant ship should run if she can. Her great object (the merchant ship) is to make her port with the cargo. She gains nothing by fighting if she cannot take the man-of-war. Honour and glory is a very good thing, but it does not always pay the piper. I think the Marine forces should certainly be increased. There is no more efficient force in the Navy, and I think also there should be more Officers in the Coastguard. We talk about defence, but England should put out her pawns and attack the enemy. Our war should be an offensive war. And as to the number of ships we have, they are quite insufficient. If you were to take the number of ships required to guard the trade from England to America, you would find that in order to efficiently patrol that trade route it would require about fifty ships. I wish to dwell upon that word "compulsion,"[1] and also on the employment of Officers, and the remuneration to the families of Officers and men who are killed in battle; for I think it is a disgrace to this country that it should fail to support the widows and orphans of men who are killed in its defence.

Admiral the Right Hon. Sir JOHN C. DALRYMPLE HAY, Bart., M.P.: I came here to be instructed, as I have been, by the information derived from the admirable essays published this year, one of which has gained the Gold Medal. There are two or three points which I should like to discuss, but I will not break the rules of the Institution by attempting to discuss them. With regard to the first,—"Comparison of the force to be employed now with that in the great war,"—it seems to me that that is a matter which, although the essay only touches one side of it, requires full consideration. At the commencement of the great war, as, I think, has been stated, the force of English line-of-battle ships was 113. I rather think it was one or two more, but at any rate I may assume that figure. Whatever may be the case, they were then equal to the combined fleets of France and Spain. It has been supposed that they were superior to the united line-of-battle of all Europe, but that was not so; there were fifteen or sixteen Dutch ships, eighteen Danish, and five Swedish, besides one or two others elsewhere which were in excess of the number provided by this country. But we consider it right to have a sufficient force to meet the two largest naval forces of any European Powers. There were, if I remember rightly, seventy-eight French line-of-battle ships at the commencement of the war, and something like fifty of the Spaniards, but of efficient ships there were not more than we ourselves possessed. In spite of that, being at war with France and Spain, and the maxim in war being the force which is inferior on the whole is inferior at the point of attack, we gave evidence of another rule, for with a force superior in the whole, we were always inferior at the point of attack. This was the necessary consequence of the wide distribution of our forces all over the world. The same thing would occur again now. There is, I believe, in this Institution, or at any rate there is on the table of the House, a recognized list of the fighting and sea-going ships of Her Majesty's Navy, certainly some of them excellent fighting ships, though some could not run away. I allude to such ships as the "Wyvern" and the "Scorpion," the "Prince Alfred," and others, which in this Institution would not be considered fighting ships, nor do I believe that they would be considered fighting ships excepting in the narrow channels of Bermuda, or in any port which they might have to defend. I believe that our sea-going fleet, at this moment, of ironclads is something like twenty-six fast ships and about eighteen slow ships, some of which are very much out of repair. It is not for me to say what the French Navy may be, but I will undertake to say this, that of ships of the size and speed of the "Inflexible," the French have about five, and the Italians have four; and if France and Italy were combined against us, it is undoubted that at this moment we should be over-matched in numbers as far as regards sea-going ironclads. I say that without reference to the 160 ironclads which exist in the world, which are not

[1] Seamen and Marines in our days, as a rule, are called upon to and do fight by sea and land; they are doubly efficient men; they should receive remuneration in proportion. *Morally* every man is bound to defend his country, but to be *compelled* to fight beyond the sea, so to speak, is another matter. *Pay* and *train* the fisher lads and youth of the country; give every encouragement to them.

likely to be combined in one effort to attack this country; but it is absurd to suppose that the force which we are in possession of is anything like sufficient for the purpose for which ironclad fleets are required. Here I may submit myself to the criticism of those who know better than I do whether what I am saying is true or not, and it is here that I differ with my gallant friend Captain Colomb. He, I think, and wisely, says that merchant ships are not the best for the purpose of naval defence, for the purpose of doing duty as corvettes, or for other purposes, and he pointed out that those which are most efficient for the purpose are those which would be very ill-spared if they were required. But I am so impressed with the difficulty of getting sufficient money for the Navy, and secondly with the necessity of first of all increasing our ironclad fleet, that I am willing to accept the 240 or 250 merchant ships, rather than divert the attention of the country and Parliament from the necessity of expending money in keeping our ironclad fleet efficient to the necessity for creating fast frigates, for which an imperfect substitute, I grant, but still a substitute, is to be found in the Mercantile Marine. There are one or two other points. In a combatant service one always likes to attack those points which have been put forward that one does not agree with. My gallant friends disagree with the Gold Medallist on the necessity for having a navigating class. Now I am entirely in favour of having a navigating class. I remember when I was a very young Officer, I thought I could navigate my own ship and I did my best to do so in the earlier commands which I possessed; but after one had greater responsibilities, that attention could not be paid to it which would divert you from other duties; and I am quite sure the gallant Gold Medallist when attending to the formidable requests of Admiral Pierre, had no time for attending to his chronometers. The laborious, the painstaking and mechanical duties of navigating a ship ought to be entrusted to one individual, and the responsibility should be upon him. I believe all the Officers who were Lieutenants with me are now Admirals, and are no doubt quite competent to navigate fleets, but I daresay they would agree with me that in navigating a fleet or a ship to select an individual of whom you have no preliminary experience, merely because he has passed certain examinations, and has shown himself trustworthy in every way, would not relieve you from that responsibility which you would be relieved from if you had an experienced, trustworthy, old navigating Officer who has had experience in that particular branch of the public service. "Jack of all trades and master of none" is a very old adage, and I prefer division of labour. Of course there are many men who are competent to learn a variety of duties, and the Surgeon alluded to on board some American ship might prove a most excellent Lieutenant; but I should prefer to have a doctor on board rather than entrust a midshipman with the duty of looking after the men, especially when it came to amputations; and I believe for all the duties of the Navy it is well, as the gallant Admiral (Boys) has already said with regard to seamen gunners, to keep the departments separate and not to endeavour to make one person *do* everything that can be required.

The CHAIRMAN: I did not attempt to interrupt a previous speaker, Captain Fremantle, who touched upon the question of the disadvantage of having a separate class of navigating Officers, and having heard one side of the question I did not interfere with Sir John Hay when he took the other side, but although the subject is mentioned in the paper I think it is hardly relevant to the subject, the Reserves, &c., of the paper.

Lieutenant ARMIT, R.N. (retired): I must apologize for troubling you, but I have taken such great interest in the Service both whilst in it, and also since retiring from it, that I cannot help rising to say a few words on this subject. The question brought before us is one that I think both the Service and the public ought to be very grateful to the Council of this Institution for having enabled the essayists to tackle. It is really and truly the subject of naval mobilization, and that is a matter that we know very little of in this country, although it has been studied in many other countries. In Germany in forty-eight hours they can man and arm their whole fleet, and practise so doing. In France they can do pretty nearly the same thing, but we, with interests far greater than all of these Powers put together, have no scheme whatever, and do not know really how we could enter upon a war with any great naval Power. Even if we have a scheme, we never exercise Officers and men at it, so that it

becomes useless. We have learned from past experience that, in these days, thanks to railways and telegraphs, breech-loading arms and all the modern inventions of science, war is no longer a thing of months or years, but is over in a few days or weeks, and it is really to the Power which can enter upon war prepared and ready to strike, and strike hard, that victory is nearly certain. We have seen that with Prussia on several occasions, and we see now the greatness of Germany owing to her preparedness. We are entirely unprepared in this country. Whether we have sufficient ships or not I will not say. As to dealing with our merchant ships, I would call attention to this fact: that these merchant ships are bound to bring the food of the people to this country, and if you take away any of those ships, you risk famine at home. The question is, have you enough ships to keep your merchant ships going, to enable the working classes of this country to have food brought to them? I doubt that very much. It is for men who are actively employed in the Service to discuss that question. I have simply risen to call attention to the fact that, thanks to the Council of the Institution, and thanks to the able essayists, we have now brought before the country the subject of naval mobilization, which is one that ought to be debated, not only here, but in every paper in the kingdom, and no man who has the interest of the Service and of the country at heart should hold his hand until some scheme has been worked out.

Captain LONG, R.N.: I really am not at all prepared to make remarks upon the very numerous subjects that are now before us. I have read three of these essays, Captain Harris's as well as those published in the Journal, and think them all very useful, but I must say the prize essay goes so minutely into the subject that I cannot pretend to have mastered it at all. There are, however, one or two points on which I should like to offer a remark. One question is, "Will the complements of ships remain as at present (bearing in mind the large torpedo-boats now carried), as to Lieutenants, warrant and junior officers, seamen, marines, &c.?" I think there is a general consensus of opinion that there are not enough Lieutenants, and that the large torpedo-boats now carried, require a petty officer. I mean to say a special "rate." If you compared the work that the coxswain of a launch used to have to do in the old days with what has to be done by the coxswain of one of these torpedo-boats now, who has about ten different levers for which he is responsible, I think you must admit that he ought to be a highly trained man. It is stated somewhere in the prize essay that warrant officers can take the place of midshipmen. I think we might say that they might frequently take the place of Lieutenants, and petty officers the place of midshipmen. Then there is another point, "Will the present-engine room staff suffice in war . . . remembering the torpedo and other steam boats now carried?" That has been remarked upon by several Officers, and I should only like to express my opinion that we are relying partly on getting the engine-room staffs from merchant ships which would be thrown out of work. Of course that means, in so far as it took place, that the Navy would, to some extent, fail to fulfil one purpose of its maintenance, viz., the protection of the Mercantile Marine, and we ought not to be dependent upon it. We now come to the Marine Officers afloat, which has been remarked upon by Captain Colomb. Of course there are comparatively few Marine Officers afloat. I myself have not been shipmate with a Marine Officer for a long time. When there is one I think he can be very usefully employed in teaching gunnery, but I do not think it would be very advisable to put him in charge of the deck. Then we have a question, "Whether convoying in the old sense will ever be resorted to?" That is the question which I considered some time ago. I certainly think it could not be resorted to. I think the convoy would offer such an opportunity for an enemy's torpedo-boats that it would be highly imprudent. Then there is the question of the "number of torpedo-boats," and in the prize essay, twenty are stated as being the actual force, with the probability of a large increase. The number "twenty" is also given in Captain Cleveland's essay. I think if we were to say 200, we should be nearer the mark. There is no doubt that small rams and torpedo-vessels must play a great part in future war, and I think (with all due deference to those who have formed the opinion that expenditure upon local defences is likely to be abstracted from the Naval Estimates) that local defences for our large ports are too apt to be neglected, and it does not seem to me possible to protect the trade of this country unless we

know that the ports at home are protected. Why they should not be protected I cannot make out at all. There are numerous fishermen on our coasts who could, if properly organized, do all that would be required in the way of working torpedo-boats. A man who goes away in charge of a torpedo-boat will find himself in a totally different position to that of charge of a ship's watch. It is more like the position of Channel trawlers or fishing boats; he is smothered in water and can hardly see which way he is going, and I think that our fishermen would be especially adapted for that sort of work. As to the possibility of enabling merchant ships to defend themselves, I should like to state my agreement with Captain Colomb, R.M.A., that the merchant ships that run the mails, the large packets, should be armed for self-defence; they could defend themselves and they could undoubtedly patrol the sea. It would be impossible for anybody else to protect them, and, therefore, they certainly ought to be able to protect themselves. In case of war, we should have to call in a great number of merchant steamers to assist our unarmed ships, and I think those steamers would very frequently be best commanded by their own proper commanders, who in many cases are Officers of the Naval Reserve. It would only be necessary to put on board a warrant officer and a gunnery staff to aim the guns, and if torpedoes were fitted, to aim them; but of course to fit torpedoes to ships would be a very expensive thing indeed, and one that I hardly think would be undertaken lightly as things stand at present, but should more inexpensive means of firing them be available, they would be of great service.

H. O. Arnold-Forster, Esq.: I rise with great diffidence to address such a select professional audience. My study of naval and military questions, though it has been long and close, has been only that of an amateur. However, as a deeply interested reader of the papers which form the subject of this discussion, I have asked permission to say a word or two with regard to some of the points there referred to. In the first place, with regard to the subject of torpedo defence, a subject to which I have paid great attention, I would venture with great submission to differ from Admiral Hamilton when he advocates entrusting the torpedo defence of our ports to the Royal Engineers. None can have a higher opinion of the Royal Engineers than I have, but there seem to me obvious reasons why this particular work should not be handed over to them. Everybody who is acquainted with the heavy work of torpedo laying, especially in a seaway or in rough water, knows very well that the qualities required are particularly those possessed by men with a sea training. The handling of boats and of heavy booms, the operations of dredging and creeping, are certain to be better performed by sailors than landsmen. Moreover, the Engineers are liable at any time to be called away to perform the ordinary military duties for which they are constituted. The only alternative is, that they should be formed into separate detachments irremovable from the sea-ports. The ordinary training of the Engineer in no way qualifies him for the work of torpedo defence; what he learns at the forts he will unlearn or forget directly he leaves them. For these reasons I cannot support the suggestion that the local torpedo defence should be handed over to the Royal Engineers. One other matter connected with torpedo warfare I should like to refer to. I see that the number of our existing torpedo-boats is one of the questions to be discussed. I have recently been able to learn a good deal of foreign equipments. I have visited the Copenhagen Dockyard, have spent a week in the military and naval section of the Moscow Exhibition, and have had frequent opportunities of observing the war vessels of the different Powers in the Mediterranean. Moreover, I have endeavoured by every means to acquaint myself with the incidents of recent torpedo warfare in the Black Sea and in the Pacific. When I consider the importance of the arm, and the activity with which other Powers have shown in providing themselves with it, I am simply amazed that this country should neglect to supply itself with an ample equipment of torpedo-boats. Of course, as the last speaker said, our existing provision is absurdly inadequate. As to the manning of the boats which do not at present exist, but which I trust we shall soon have, I venture to make a suggestion which may commend itself to some here. It is that an arrangement should be made for instructing the yachts' crews, which form so important an element in our nautical strength, in the handling of the torpedo-boats,

which in my opinion ought to be stored in large numbers round the coast. The experience acquired by yachtsmen in working small steam vessels at high speed would be most valuable; and the particular nature of torpedo enterprise, the dash, the independence, the initiative, would doubtless commend it to the class of seamen I have mentioned. As to the question of non-combatants, I entirely agree with the criticisms which have been made with regard to the existing condition of things. It appears to me most undesirable that the very large engine-room staff which is now borne on many of our ships should be almost altogether uninstructed in combatant duties. Only I would say that such instruction should be made a part of, and not additional to, their ordinary work. And lastly, with regard to the whole subject under debate, I must confess that to me, as a civilian, it does appear perfectly astounding that it should be left to such an Institution as this—important though it be—to discuss this matter of mobilization. That it should be taken for granted that in this very A B C of naval warfare, no steps, or insufficient steps, have been taken by those officially responsible, seems almost incredible. If this discussion does nothing more than rivet the attention upon the fact that we have not yet reached the point from which every other nation starts, it will not have been in vain.

Commander G. O. Moore, R.N.: The question of the Naval Artillery Volunteers having been mentioned here, I trust I may be permitted to say a few words with regard to them, having occupied the position of Instructor of the London Brigade for nearly three years. I must say I think the gentleman (Curtis) who met the volunteer at Windsor was singularly unfortunate in the man he met. With regard to the London Corps in particular, there are many of the men who are capable in a small way of doing a good deal of seamanship. I will instance one man who, single-handed, sailed a five-ton yacht in a handicap from Erith to Ramsgate, and he not only did that, but he won the handicap against yachts fully manned. That man is still in the corps. I, as instructor, am bound to return as efficient any man who possesses a competent knowledge of gun, rifle, and cutlass exercise. I am very sorry to say I am bound to do so, I cannot ask him to do any more; but with regard to the trained men, we qualify on the analogy of no one being permitted to be a trained man in the Navy unless he is a first-class ordinary seaman; we insist that the man should be able to pull an oar, steer a boat, and make all the ordinary knots and bends in use. We cannot go further because we have no means of instructing them. With regard to the men themselves, my experience of them is, that whatever they are asked to do, they will do most willingly. I have never had any one object to anything that I asked him to do, and I think if anything is wanted of them they will be most ready to do it.

Captain Johnstone, in reply, said: Mr. Chairman and Gentlemen,—I think some of the speakers have perhaps a little overlooked the fact that the subject of the essay is a strictly limited one: that the essayists were called upon simply to answer a particular question, and that they were very much limited. Of course it was impossible for them to restrict themselves exactly within those limits, but I think that it is perhaps a little unfair that fault should be found with them for not having gone further than they have done. I think in my own essay I made it as clear as I could, that the organization was for the existing *personnel* as applied to the existing *matériel*, without giving any opinion as to whether the *matériel* was sufficient or insufficient, but simply saying how the *personnel* should be fitted on to it. Admiral Hamilton, objecting to the proposal for a stationary Naval corps to defend our ports, thinks the Royal Engineers do it better. There is one fatal defect in that, and this is that the Royal Engineers are not one-hundredth part sufficient to do it; there is nothing like the number of Royal Engineers to defend all our own coasts and the coasts abroad. I happened to be on the Local Committee for the defence of the Colonies at Singapore, and of course I went into that question, and the number of Engineers there employed was something ridiculously small. There were great questions as to how the number could be supplemented, and they did in reality fall back upon natives, native boatmen, anybody they could get hold of to assist them in the ordinary work that did not require technical training. Admiral Hamilton says that our Navy is not a defensive force but an offensive one. Of course there are two sides from which you can look at the question, but I think one of the

great glories of the Navy is, that it is primarily a defensive force; that, war being a necessary evil, the Navy is to defend ourselves before it is intended to attack other people: that if we never intended to go to war any more, we should still keep a Navy, and therefore the fact is, our Navy cannot be called altogether an "offensive" force. There is not the slightest doubt that we should endeavour to carry the war into the enemy's country as far as we could, and to keep them from our shores, but the time may come—I hope it never will—when the Navy may be removed to a distance, and we shall have to defend ourselves at home in its absence. We know that at present we have not got the force to defend these shores. There is no doubt the defence of our ports may be conducted by men who have not been trained regularly as seamen, and that being the case, why should we not employ such men? We know at the present time it is impossible to give our seamen as much training at sea as we could wish. Boys, when they have passed through the training ships, are frequently kept at home because you cannot give them training at sea; and that being the case, why should you waste their services upon work which can be as well performed if not better by your boatmen? As far as handling boats, working in such waters as Spithead, Plymouth Sound, or anywhere else is concerned, I think we may say that our boatmen are certainly more suitable for the work than our naval seamen. It is not at all an uncommon thing to find a seaman in the Navy who is a very poor man indeed in a boat; indeed, it is quite an exception to take a man haphazard, put him into a boat, and find that he is able to steer it under sail; therefore considering the work that the Navy has to do, I think that some other force is advisable for home defence. With regard to the fact of Newfoundland not being a particularly good recruiting ground for the Navy, I think it was not exactly a question of getting men into the Service, but of engaging men who might be called out for a month's training in the year, and who would then have to defend their own coasts. I do not think the same objection would apply to such work as that for them, as there would to going to sea in a man-of-war; the discipline and the work would be altogether different. Admiral Hamilton seems to have thought that my paper overrated our strength, but I think, if he would look at the remarks at the conclusion of the essay, and also at the end of the third chapter, he will find that I have clearly explained that I do not think the force sufficient. Captain Fremantle thinks that we start with a surplus of men. There is no doubt that on paper it is a surplus, but there are a great many necessities that arise; and if war breaks out with the amount exactly put down on paper at the present moment, I think we should not have a man too many. I do not think we are actually short of seamen to start with, but we ought to have something to fall back upon. As to the efficiency of the engine-room staff, I think I have made it clear, in Chapter III, that I did consider that there was great deficiency. As to the Marine servants, I did not mean to say that I thought the Marine servants should be withdrawn and civilians engaged instead, but I think that our object should be to have as many seamen as possible, and I should draw them from the seamen class. Servants should be selected from the men and boys who pass through training ships, they will make as good servants in every way as civilians, and you will have men who will be able to do the work of the seamen as well as any others. With regard to the navigating class, I did not mean to speak especially in favour of that class; but the fact is that our number of Lieutenants, as distinct from navigators, is lamentably deficient, and we can only get anything like an approach to a proper number by throwing all the navigators back into the body of Lieutenants and then supplying the place of navigators. There is no doubt we can supply the place of navigators, but we cannot supply the place of lieutenants. Nothing can supply the place of an Officer who is trained as a Lieutenant in the Navy. You may promote a Sub-Lieutenant and obtain a Lieutenant in that way, but that is your only way; and of course if you promote all your Sub-Lieutenants, who have you left to do their duty? It is the only way of increasing the Lieutenants' List, to take them away from navigating duties, and to supply the place of navigators as well as you can. It is very well recognized that when a Lieutenant is put on one side for navigating duty, he does not do much duty as a Lieutenant, in fact, he does no more duty than a Master would have done. I know that in some ships the Captains say that as the Navigating Lieutenant gets extra pay, he ought to do more, and guard duties, &c., are added, but

after all it is a very small matter. When a ship goes to sea, he is a Master and nothing else, and if you take him out of that duty and send him to his regular duty in charge of quarters, you may just as well have somebody else there virtually a Master; that is the only way of supplying the deficiency of Lieutenants. Admiral Selwyn spoke of the number of pensioners. The question as to the available number of pensioners seems to be rather obscure, and I should imagine the Admiralty felt that when they established the Seamen and Marine Pensioners Corps, that is to say, a certain number of pensioners have engaged to come forward for fourteen or twenty-eight days' training every year. They are trained in modern requirements, they get a pension at an earlier period, and it is known exactly how many they are. The vote last year was taken for 1,750. As to the Colonies defending themselves, I have not the slightest doubt that they are quite prepared to do so, but there is not at present any organization. We have these enormous forces for defending the Empire, and yet there is no sort of organization for getting them together. There are two or three colonial ships, and a few gunboats. Of course this is the beginning of the thing, but there is no sort of organization, and no real encouragement. They are praised for their efforts to prepare their own defence, but after all it is not an organization, and the single efforts of a Colony will not make up for the system which is absolutely required. As to the formation of a corps of retired Officers, the objection was that an Officer who has been on shore a great many years knows nothing at all about the Service. It is well known that Officers on ordinary half-pay get pretty rusty, and when Admiralty circulars increase at the rate they do now, it is quite necessary to keep yourselves well up in the matter. My idea was, that a body of retired Officers would be trained; in fact, the body would be analogous to the Seamen Pensioners Corps. They would be kept up with the changes in the Service, and there is no doubt a good many retired Officers are very fond of the Service and would be very glad to keep up with it in any way. Captain Colomb spoke of the 100 ships that it is proposed to take up. There again I must say it was merely fitting on the *personnel* to what is supposed to be the present requirement. The Admiralty have, I believe, a matter of over 200 ships on their list to be employed in the Navy, and it is naturally to be supposed that a great many of these will be absolutely employed, and therefore it is necessary to provide complements for them. I do not say that the number would be 100, but I am inclined to think the number of men who would be taken for that would certainly not be less than I have estimated in my paper. As to the power of expansion not being noticed, I think it will be seen in the earlier part of the paper. Admiral Boys spoke of the Royal Engineers working with the Navy as a torpedo force, and the difficulty there was in the first place. The difficulty is not entirely at an end, because at one place where I was abroad the Engineers made their demand in the proper form on the Navy for boats in order to carry out some experiments. The answer was that there were no boats, and there was a long telegraphing going on between the senior officer on that station and the nearest naval *depôt*. At last, there being no chance of getting boats, the Engineers took the bull by the horns and forthwith ordered a number of boats, and bought them then and there. The question was, who was going to pay the bill, because it was not a small one at all. However, I never heard any more about it. With regard to compulsory service, and the question of the widows and families of men killed in action being provided for, I believe at the present time the Admiralty do provide for them. By an order, about a year old or rather more, it was arranged that the widows of all men killed in action or directly in the service should be provided with a pension out of the funds of Greenwich Hospital. (The CHAIRMAN: And the children?) I believe that has been satisfactorily settled. As to our seamen being ignorant of a great many points they ought to know, I think there is no question about that. But that is the fault of our present system of training. It has been alluded to by other Officers at different times, and there is no doubt that our men come out of the training ships just like bullets cast in a mould. They work together, but they have no sort of new idea. It is quite an exceptional thing to find a man who has any idea different to what his fellows have. Some years ago, when you got seamen from different sources, I think there was a much larger amount of resources amongst them, but now they are prepared to produce the

amount of knowledge they have been taught and in many cases very little else. Captain Long, speaking of the complements, said he thought there were Lieutenants enough, and it was suggested that warrant officers might take their place. There is no doubt that warrant officers would have to take their places to a very large extent, for I really do not see who is to command our torpedo-boats when we have a large number. At the present time we have a very small number, and therefore the difficulty has not presented itself. It requires a very steady experienced person, a man accustomed to handling boats, and I am quite certain an ordinary person who has not had any experience, if put into a torpedo-boat would not have the slightest idea how to manage it. Captain Long also spoke of the *personnel* being fitted on to 20 boats, only he said there ought to be 200. I think, perhaps, there ought to be 200, but the fact remains that there are only 18 at the present time, and therefore it is no use providing *personnel* for any more. Mr. Arnold-Forster spoke of the use of yachts' crews for torpedo-boats. I think that is part of the question of the Stationary Torpedo Force and Sea Militia. I take it in the Sea Militia you would obtain the services of every man available; in fact, if they were obtained compulsorily you would naturally take every yachtsman, waterman, and fisherman near the place. They would be organized into a body who would be required to come up for training for fourteen or twenty-eight days every year. They would be paid for their services. It would not be an arduous service in any way, and at the same time you would get the men who, I think, would certainly be most suitable for the work. For coast work of any sort there is nothing like people on the coast; they know the tides, they know the prevailing winds, they know how to cheat the tides, where to run for shelter, and no man taken haphazard would be able to do that. As to the question of there being no preparation by the Admiralty for mobilization, I think it is rather bold to say that. There may be a scheme for organization for all we know, it is not published, but still it is quite possible that there may be some complete scheme, and certainly the First Sea Lord said some time ago that the question of the best organization of the *personnel* had been under the consideration of the Admiralty for some two years or more. How far they have got in that scheme, of course it is impossible to say.

The CHAIRMAN: I am sure you will with one voice return thanks to Captain Johnstone. Before we close, will you allow me to make one or two remarks? I have always been surprised, as no doubt you all are more or less, at the extraordinary difference that exists between the French Navy and our own as to this *non-combatant* question. When I was in command in China this was quite startling to me, and I made out a tabular arrangement of the ship's company in the French Flagship—an ironclad—and in my own. I found that the French, with a smaller ship's company, had over one hundred more combatants. She had only *five per cent.* non-combatants. They took immense pains that every man should be drilled. Their artificers were, as much as possible, taken from the seamen class, or drilled. The French naval authorities laid great store by this. Although they were, as in our Navy, losing masts and sails, yet if possible they endeavoured to keep the seaman element to the front. My own *personnel* had 37 per cent. non-combatants, and now that we have so largely adopted the "Monitor" class, I am almost afraid to name the percentage of non-combatants there are in our war ships. I think they outnumber the combatants. You may say you do not want the non-combatants to be sailors, but they ought at least to be able to defend themselves, to know the use of their arms. I made an investigation as to those Officers who knew the use of their arms on board my flagship. Of course the effective Officers did, but the non-effectives, engineers, surgeons, &c., did not know one end of their swords from the other, so far as to be able to make effective use of them. None of the stokers nor artificers could use their arms; they were not supposed to know how to use the rifles if they were supplied to them. I took the liberty of examining the stokers at firing at a mark, but I received a very broad hint that the expense incurred would be charged against my pay. These men would like to learn how to defend themselves, and it would be of real use to the stokers and the artificers to come up and compete for prizes at rifle shooting, &c. I found that that relaxation from their ordinary work was an intense pleasure to them. In my opinion, the Chaplain should be the sole exception to a rule that every Officer, seaman, boy, &c., should know how to defend

himself with rifle, revolver, and sword. With regard to the number of Officers in reserve available in case of war, there is an enormous difference between the French system and our own. The great Colbert established the grand *Inscription Maritime* of France, and when you can get a French Naval Officer aside, and talk to him about it, he will say that what is nearest his heart in his Navy is their *Inscription Maritime*. The number of men they take from the Merchant Service, fishermen, &c., and pass through their service every year, viz., all those who reach their twentieth year, quietly, is from 5,000 to 7,000. They have not a very large Merchant Service, or fishing population, but yet they pass through the Navy from 5,000 to 7,000 men. They keep them for three years' drill; they can keep them for five if thought advisable. They make them 50 per cent. better men and seamen than when they came in—educated, orderly, respectable—and there they are, a splendid body of men, loyal to their country, and ready in case of war. During the Franco-German war, they sent 30,000 men to defend Paris. How many thousand could we send out of our naval force to defend London if we were at war? They have about 70,000 men in that condition, some actually serving in men-of-war, and others who have passed through this long service. It is a magnificent reserve, of which we do not hear much, but we may hear a good deal about it some day. As to the Officers: they have some 5,000 Officers in the Merchant Service, 2,000 *capitaines de long cours* and 3,000 others ready to come on board their ships of war when they are wanted, all of whom have been through their three to five years' drill on board men-of-war. Now how many have we got? We have a Royal Naval Reserve of Officers, a useful reserve, as far as it goes, better than nothing, scattered about here and there. But if you ask any one of these Officers Royal Naval Reserve, Lieutenants and Sub-Lieutenants, when they took their last drill, I do not think that many of them could well tell you. They are too busy; they are among the best men in the Merchant Service; what time have they to go and take a drill of a month every year? They cannot find time to do it, and they are excused. There are very good names among them, but you cannot expect to get much work out of the Lieutenants of the Royal Naval Reserve—*commanding* large steamers in peace as *Lieutenants*—in a naval war, watch-keepers in men-of-war. That constitutes the enormous difference between us and the French. A remark has been made with which I entirely sympathize as to the *stokers*. During an European war, I suppose we might get all the stokers we wanted at first out of the unemployed merchant ships, but they would come for the first time under naval discipline, and you would have a great deal of trouble with them. We might have some in the Coastguard, of course. That would go a certain way to meet the difficulty, but it would be one of the most startling difficulties that we should have to encounter if we were ever plunged into a great European war. We have talked about the *German* system of *coast* defence. When I was a naval *attaché* a few years since, just after the Franco-German war, I found the Germans were very intent upon defending their coasts properly and thoroughly with torpedoes, booms, and nets of every description, and it occurred to them, not unnaturally, that *sailors* were the best men to handle boats and spars in the water, and so forth, particularly in bad weather. The German Naval Officers always pitied their dear brother soldier when they saw him put into a boat and tumble about in her in a seaway, and therefore the German authorities readily gave this work to the Navy. However, the military element was too strong in Berlin (with *General* Stosch at the head of the Navy, who, no doubt, had a military bias) that the duty was taken away from the Navy and handed over to the Army. It was, however, entrusted to the Navy at first; it was not that the Navy failed, but it was thought to be a *military* affair, and was passed over. Our Government jumped at once at the same time to the same conclusion, and put the coast defences into the hands of the *Royal Engineers*, a splendid body that will try to do anything that it is told to do, and succeed if it be possible; but when we see the struggles they make in their boats in a seaway, I have no doubt they feel rather ashamed of themselves (but unnecessarily so) for making a mess of things which they could not possibly do thoroughly well. It is asked in the paper, "To what extent is it possible to depend on the estimated number of men in the Royal Naval Reserve and the Royal Naval Reserve Volunteers being available when required, and what their real efficiency will be?" Their real

efficiency will be simply this: that you have the best men in the Merchant Service. You cannot rely upon foreigners. There are thousands of foreigners that you will not be able to touch in time of war—Swedes, Norwegians, Germans, Italians, &c. It is not to be expected that they would fight under our colours even if we accepted to have them; there would be a row if they did. We should have to fall back, therefore, on the English element in the Merchant Service. We have entered in the Royal Naval Reserve pretty nearly *all* the English able seamen that are worth having from our point of view; the 11,000 will pretty well exhaust the whole number of English seamen available in the Merchant Service. I should be very glad to hear that I was wrong in this matter, but when I commanded that force for three years, I was always told that the residuum was very small, and not worth much. They receive from 10*l.* to 12*l.* a-year, but you have nearly everybody that you can get that is worth having. They are the "cream," but they are unfortunately very few, as somebody said of the British Infantry. As to whether they can be depended upon, my belief is that they can be thoroughly depended upon. They are loyal, patriotic English sailors, and you may depend upon them to the last man. This was very much doubted at first. There were many critics when the Royal Naval Reserve was established who said, "The moment you go to war they will be off, and you will not get them," and that was believed for some time. The Royal Naval Reserve was originally a very small force, about 2,000, but when Messrs. Mason and Slidell were taken out of the "Trent," and there was a prospect of war with America, and these prophets of evil began to say, "Next muster you will not find any of these Naval Reserve men," the result was that they trebled in number in a few weeks, without having any impulse given to them other than that there was a prospect of war. That to me was an absolutely sufficient test as to the tone of the whole body, and I do not believe that any one who knows what he is talking about, has now the slightest doubt that the Royal Naval Reserve is a perfectly dependable force. There is also a Second Class Reserve of great value, consisting chiefly of fishermen, and the Royal Naval Artillery Volunteers, recruited from well-educated young men in the maritime towns, who will, I doubt not, distinguish themselves when they get an opportunity. I will now in your name tender our hearty thanks to Captain Johnstone for his admirable essay.

Friday, June 20, 1884.

THE RIGHT HON. THE MARQUIS OF HARTINGTON, M.P., Secretary of State for War, in the Chair.

THE HEAVY GUNS OF 1884.

By Colonel E. MAITLAND, R.A., Superintendent Royal Gun Factory, Woolwich.

IN the spring of this year the Council of the Royal United Service Institution did me the great honour of asking for a lecture on the subject with which my work is chiefly connected, viz., "ordnance." The Secretary of State for War cordially granted permission, and moreover most kindly consented to take the chair on the occasion. I felt, therefore, that the time had now arrived for as clear an exposition as I could lay before you—and through you before the public—of the present state of this subject, which is of national importance, setting forth the causes which had led to the necessity for the re-armament of our naval and military forces, the progress now made in that re-armament, and the comparative efficiency of the heavy guns of 1884 in England and in the other chief countries of the world.

As time is short, you will pardon me for being exceedingly brief in summarizing the chief causes which have led to our re-armament.

Putting aside all minor considerations, many of which have frequently formed fertile matters of controversy, I state at once that the chief causes are three:—

1. Improvement in powder.
2. Improvement in mechanical appliances.
3. Improvement in production of large masses of steel.

It will perhaps be said that if this be true, these considerations should affect other nations besides our own, and that the great Continental Powers should be re-arming extensively also.

To this I reply that this is exactly what they are doing, and have been doing for some time past. Their re-armament is being carried out rather more gradually than ours, and the changes they are making are less radical, but none the less are they thoroughly re-arming. It may be admitted that during the latter part of the seventies England fell behind in the artillery race, but not to the extent that is supposed by many who have not thoroughly studied the subject. As a matter of fact, the old short breech-loaders of the Continent are just as obsolete now as the old short muzzle-loaders of England, and up to about 1875 or 1876 the British artillery was as good as anybody else's. Then came

a period of comparative stagnation, and we fell to leeward. During the last three years we have been endeavouring to make up our leeway.

One point we have in our favour. In a science which advances as fast as artillery has been doing of late years, the Power which waits longest before committing itself to a new manufacture has the best of it, always supposing that it is not caught napping by an important war.

It is not necessary to explore the debateable land of the Might-have-been; it is sufficient for our purpose to know that we have *not* been caught napping by an important war, and I hope to show you to-day that the result is that having waited the longest, we have got the best of it.

I come now to the improvement which has taken place in powder. It must be remembered that the weight of the gun is the limiting element of power in nearly all cases. It is easy to carry about powder and shot, but the gun is one and indivisible, and taxes the appliances of transport to the utmost. Hence as long as guns have no special counter-balancing points of advantage or disadvantage, the proportion between the energy attained by the projectile and the weight of the gun forms a convenient way of comparing the excellence of various designs. It is briefly called "energy per ton." Conversely, the description of powder which enables a gun to realize the greatest energy per ton without exceeding the pressures which it is constructed to bear, will be the best for that gun, irrespective of the quantity of powder expended in producing that result. There are cases no doubt where the size or weight of the cartridge becomes a serious consideration, but as a rule it is of little importance when compared with the advantage of increased power.

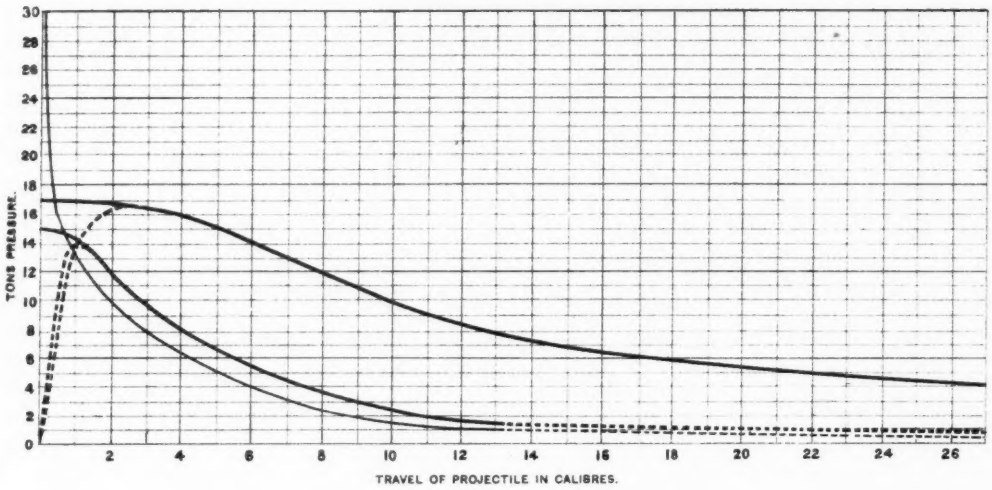
With breech-loaders that powder is found to be the best which satisfies the following conditions. It should fill the chamber of the gun as completely as is consistent with facility of loading. It should burn slowly at first, till the projectile begins to move, gradually setting up just the maximum pressure suitable to the gun; it should then burn faster and faster as the projectile travels onward through the bore, so as to keep up the pressure as long as possible, and give the greatest amount of energy. A low maximum pressure long sustained is the great desideratum of the artillerist, and no one will attain any measure of ballistic success who fails to recognize this fundamental maxim.

Diagram No. 1 (Plate XXIII) shows clearly the amount of progress which has been attained in slowing the powder and producing energy per ton of gun.

The ordinates represent the pressure of the gas measured in tons per square inch; the abscissæ show the length of travel of the projectile along the bore measured in calibres.

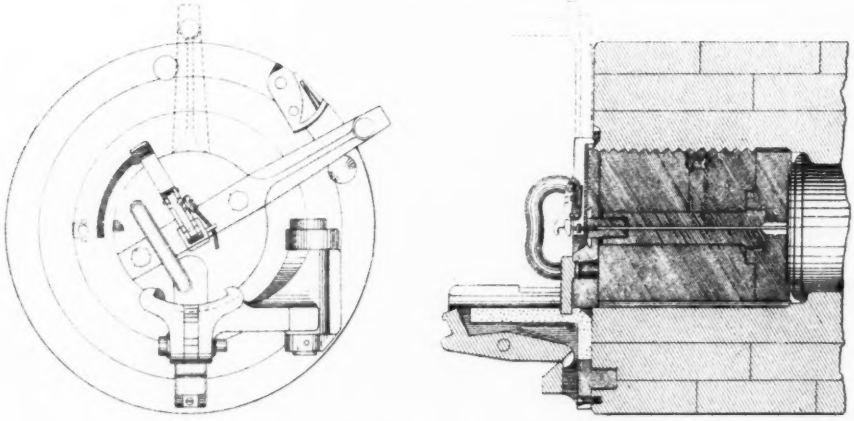
The fine curve indicates the pressures with quick burning powder, the medium curve with medium powder, and the thick curve with slow powder. The quick and medium powders were used in short guns, and the dotted portion of their curves is merely added to show

I. COMPARATIVE POWDER PRESSURES.



III. BREECH ACTION.

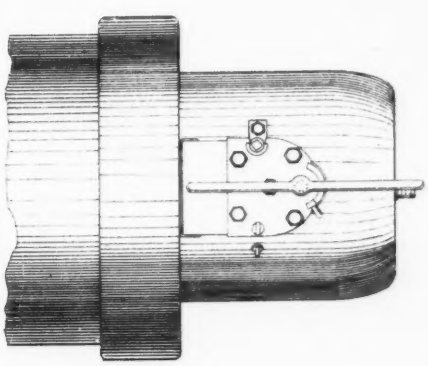
FRENCH MARINE SERVICE.

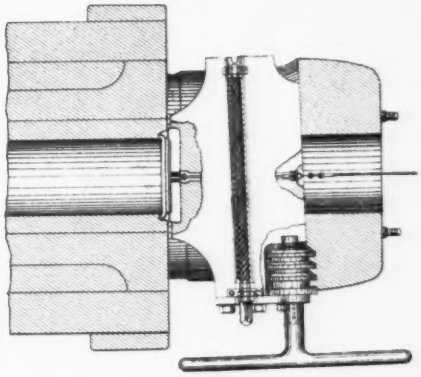


Harrison & Sons Lith. S.W.

II. BREECH ACTION.

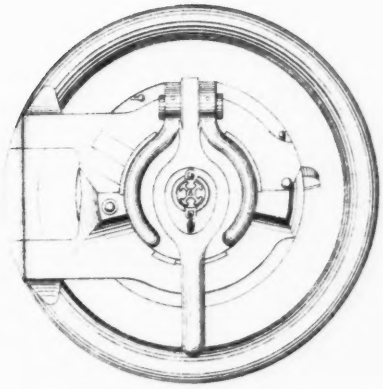
KRUPP.

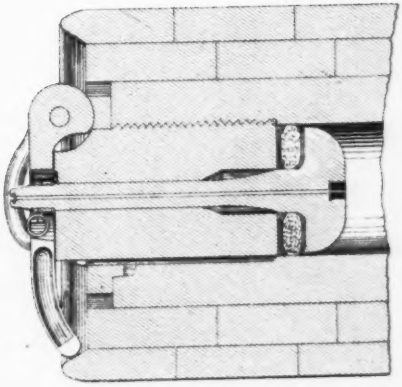




IV. BREECH ACTION.

FRENCH LAND SERVICE.



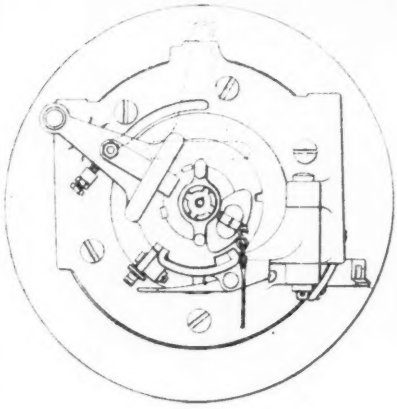


...mson & Sons Lith., 3, Martins Lane, W.C.

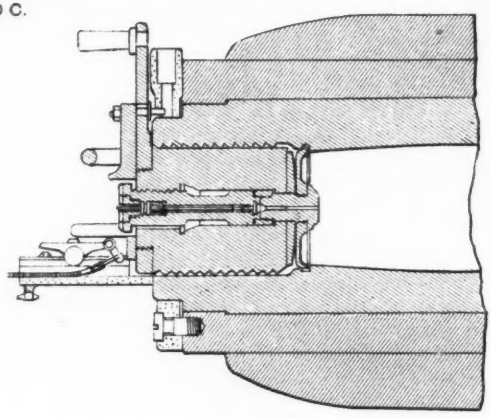
V. 6 INCH B.L. GUN. 80 CWT.

BREECH ACTION.

E.O.C.



BREECH SCREW LOCKED READY FOR FIRING.

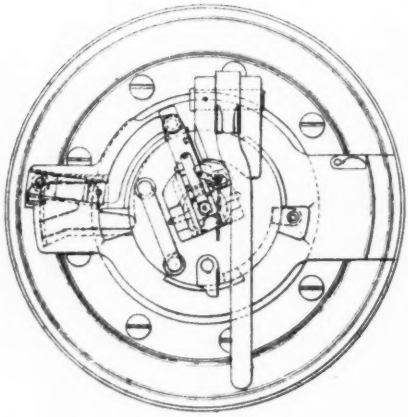


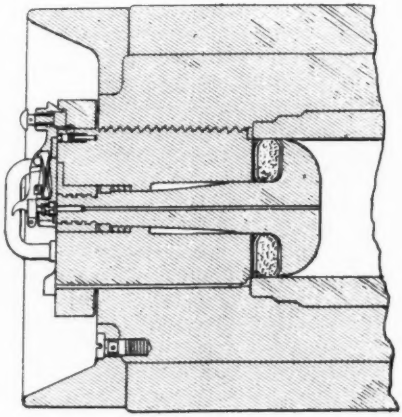
BREECH SCREW UNLOCKED READY FOR WITHDRAWAL.

VII. 6 INCH B.L. GUN. 89 CWT.

BREECH ACTION.

R.G.F.



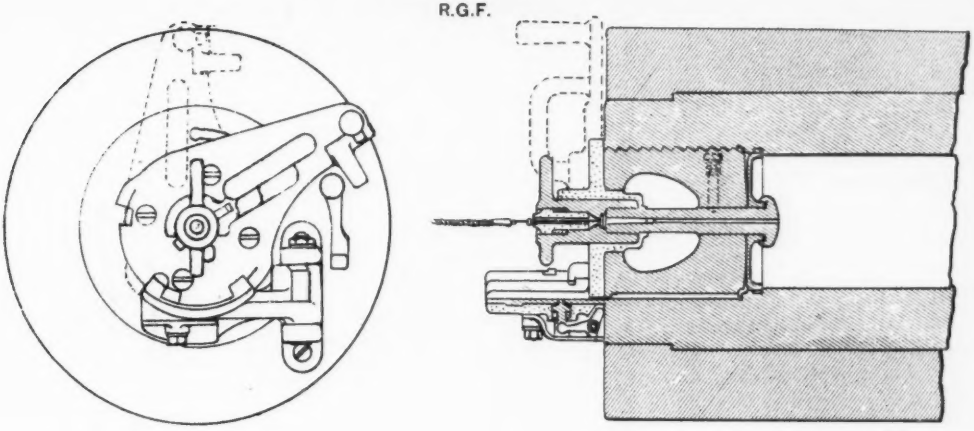


Harrison & Sons Lith. St Martin

VI. 6 INCH B.L. GUN. 81 CWT.

BREECH ACTION.

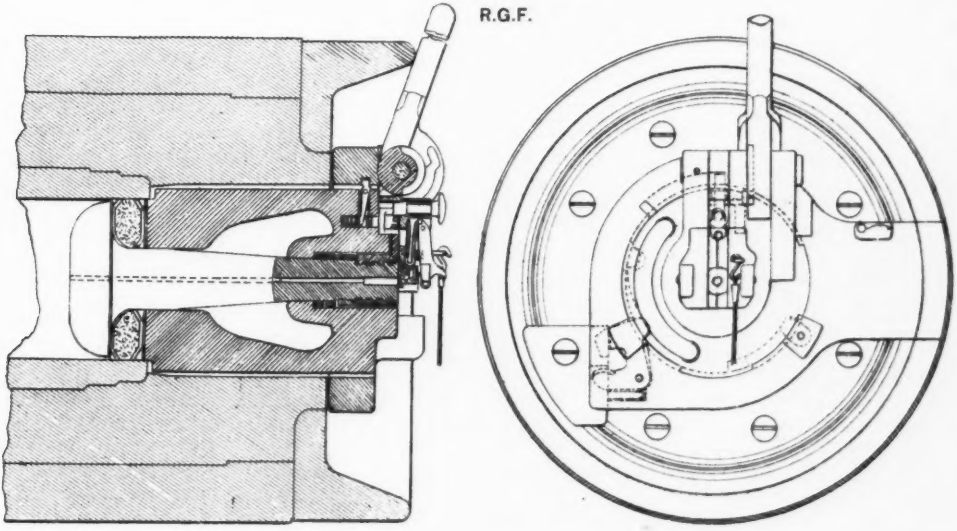
R.G.F.



VII A. 7 INCH B.L. GUNS. 10 TONS.

BREECH ACTION.

R.G.F.



& Sons Lith. St Martins Lane W.C.

how little gain would have resulted from increase of length. The slow powder is used in long guns, and the amount of pressure kept up to the muzzle indicates that we can go still further in the direction of length with advantage. The area included by these curves of course represents the work done by the powder, nearly all of which goes to produce energy in the projectile.

It at once becomes evident that to get an increased ratio of power to weight, we had to turn thickness of metal at the breech into length at the muzzle: that is, to lower the pressure in the chamber and keep it up longer in the bore.

We sometimes hear statements to the effect that the road to improvement lies in the direction of using very quick powders, and making enormously strong guns to withstand the highest pressures powder can give in a closed vessel, viz., about 42 tons per square inch. This system, from an engineering point of view, is no doubt right as causing the least consumption of fuel; but it is utterly and entirely wrong when seen from the artillerist's standpoint. The artillerist cares little for the amount of fuel consumed, but a great deal for the weight of the machine consuming it. Now, when guns are fired with powders giving different pressures, it is found that the rise in energy of projectile at the muzzle is not nearly in proportion to the rise in pressure in the powder chamber. High pressures are extremely capricious and uncertain in their effects, and no precise rule can be laid down, but taking our usual service maximum pressure with slow powder at $17\frac{1}{2}$ tons per square inch, and substituting an equal quantity of a powder violent enough to give 35 tons per square inch, I should not expect to realize an increase of energy of more than about 20 per cent., though the pressure has been doubled.

But doubling the pressure necessitates doubling the strength of the breech, and hence of adding about 80 per cent. to the weight of the gun. Besides this, high pressures give rise to many inconveniences, the breech fittings and the firing arrangements are apt to be burred, set up, and jammed; the shell and shrapnel are liable to be broken up in the bore unless made so strong as to reduce seriously their capacity for holding bullets or powder.

Hence I think it is clear that slowing the powder is a most important improvement.

There are two reasons why this improvement in the powder renders breech-loading an absolute necessity. First, the guns have to be made so long that loading from the muzzle becomes practically impossible on service. Second, the slow powder cannot be made to burn in the most effective manner unless the projectile be held fast by a strong band which prevents it from moving till a pressure of from 1 to 2 tons per square inch is set up in the chamber. This can only be done in breech-loading guns, and hence they are capable of developing greater power than can be obtained from muzzle-loaders of equal weight.

I am aware that two or three years ago, when breech-loading was young in England, this view was strongly combated by some of our most able artillerists, who held that muzzle- or breech-loading *per se*

made no difference in the power of a gun; but now I think its correctness has been established by frequent experiment, and will hardly be questioned.

Here it may be seen how, by coming last to breech-loading, England was able to build on Continental experience and improve upon it. In 1880 we were using for our heavy muzzle-loaders either Waltham P^2 or German prismatic powder, which gave, when proved in the 38-ton M.L. guns, pressures of about 19 tons, and velocities of 1,560 f.s. Directly the Royal Gun Factory came to breech-loading, the unsuitability of these powders became apparent to us, though the German prismatic powder was specially manufactured for Krupp breech-loaders. The Superintendent of the Royal Gunpowder Factory at Waltham was promptly asked to make a powder which should give about 800 f.s. velocity in the 38-ton gun with a pressure of not more than 5 tons, using the same charges as with the German prismatic. This modest request would probably have met with derision if regarded simply from an engineering point of view, as involving an absurd waste of fuel, but Colonel Brackenbury tackled the matter very successfully, and, after some preliminary trials, produced an admirable powder, which attained celebrity under the name of H_3. This powder was nearly useless for muzzle-loaders, but when fired in heavy breech-loaders gave by far the best results then known. A modification of it has now been introduced and issued for service as C_2. Since the production of H_3 the Germans have taken a fresh departure, and have quite lately produced a powder which seems to be a little better than C_2. It is known as cocoa powder, and its composition is a secret.

The speciality of this cocoa powder is that although it lights with great regularity and burns very slowly at first, yet when the projectile has got fairly under way it burns with tremendous rapidity. In the 19-ton 9·2-inch guns it has about the same ballistic excellence as the best lots of C_2; that is, it gives about the same pressures and velocities all the way up the bore, but it takes only 170 lbs. of the cocoa to produce the results attained by 200 lbs. C_2. These charges give about 2,050 f.s. velocity to a projectile weighing 380 lbs., the pressure being about 17 tons in the chamber. Thus the extra 30 lbs. of C_2 are required to give off gas as the projectile travels through the bore, to balance the quicker final burning of the cocoa powder.

Darwin tells us, in one of his charming books, how the probosces of the Madagascar moths tend to lengthen in successive generations so as to reach the honey-dew of the orchids, while the nectaries of the flowers tend to deepen continually to force the moths to push their heads in and exchange the fertilizing pollen. So we find, in the struggle for existence, the guns growing longer and longer to get the best effects from the slow powder, while the powder tends to grow slower and slower to meet the wants of the guns, in accordance with the eternal principles of evolution.

The next point is the improvement made in the mechanical appliances of guns.

With a breech-loader the first necessity is a thoroughly satisfactory system of closing the breech. This was certainly not accomplished

by any nation till after the Franco-German war of 1870. Krupp then entirely remodelled his breech fittings, and introduced the form now universal in his modern guns. The French Marine improved the details of their existing system in like manner, and the French land service, after a long series of experiments, retained their system of closing the breech, but adopted an entirely new method of obturation invented by De Bange of the French Artillery, to whom I am very pleased to have this opportunity of expressing my gratitude.

The great Elswick firm also adopted the French system of closing the breech, but applied a method of obturation of their own.

Thus during the seventies, four really serviceable methods of working the breech and sealing the escape of gas became available, and one of the great objections to breech-loading disappeared.

The two first causes named, *i.e.*, the improvements in powder and breech actions, settled the question of breech-loading *versus* muzzle-loading; the third cause of re-armament, viz., the production of steel in large masses, affects construction only.

Were large masses of steel not available, we should still have to re-arm with breech-loaders; but the old system of construction would no doubt be retained, and the change we have made would not be of so radical and complete a character.

In bringing forward the Army Estimates in March, Lord Hartington stated to the House of Commons that, "With regard to the supply of heavy guns for the Navy, fair progress has been made in the present year. During the present and the past two years we have been undergoing a double transition; first, from the muzzle-loader to the breech-loader; and, in the next place, in the material, from wrought iron to steel. Twenty years ago another transition took place, which was of an exactly opposite character. Twenty years ago we reverted from the breech-loader, the more complicated gun, to the muzzle-loader, or more simple gun, retaining the same material of manufacture. At that time the largest guns in the Service were of 7 tons weight, firing 30 lbs. of powder. In the change from the muzzle-loader to the breech-loader the guns are of 40 tons weight, firing 400 lbs. of powder. The Committee may, therefore, imagine what has been the difficulty, and the necessity there has been for hesitation and caution in undergoing such a transition under such circumstances. The main difficulty has been to obtain sufficiently large steel forgings for these immense weapons. There are in France and Germany several firms which have been able to supply steel forgings of the size, and also of the quality, required for these guns; but up to the present time the demand has been a new one to the English trade, and there has been great difficulty in obtaining from the English trade steel forgings of the size and quality required."

This precisely sums up the case, and shows how the improvements introduced into the manufacture of large masses of steel have affected our re-armament.

I speak in general terms of the material of which our new guns are made simply as steel, because I wish to avoid entering at all upon

the vast question of the innumerable qualities and attributes of this wonderful substance.

Although its manufacture is still far from perfect, and will probably not be reduced to anything like an exact science for many years, yet sufficient is known about it to afford matter for many lectures, and I cannot venture in the short time now at our disposal to touch the subject at all. For the purposes of the present lecture I must ask you to take steel as steel.

On the occasion just referred to, speaking of the progress made in our re-armament, Lord Hartington went on to say, "We have supplied, or in a few days shall have supplied, to the Navy 10 guns of 43 tons and 12-inch bore, 18 of 18 tons and 9·2-inch bore, 8 of 12 tons and 8-inch bore, 171 of 4 tons and 6-inch bore; besides 190 smaller guns of 2 tons and under, making a total of nearly 400 new breech-loading guns. Those first in hand were of mixed steel and wrought iron, while the later guns are entirely of steel. There has been some advantage in the delay in the adoption of the new pattern of breech-loading ordnance. We have had the advantage of the experience gained by France and other Powers, and it is believed that we have now obtained a system of breech-loading of a simple and efficient character. In addition to the guns I have enumerated, there are in hand, under construction for the Navy, 3 guns of 110 tons, 4 of 63 tons, and 3 of 43 tons, besides a very large number of smaller guns in various stages of progress. At the same time, there are under construction for the land service 10 guns of 43 tons, 4 of 26 tons, and other guns of smaller size."

This brings the state of affairs down to about three months ago, since which time the manufacture has been steadily proceeding, but of course no important change has been made.

I will now endeavour to give you some idea of the relative excellence of the latest types of heavy guns at home and abroad, selecting three separate features for comparison as being of a crucial character.

These features are—

1. The system of breech-loading and obturation.
2. The construction.
3. The power.

Diagram 2 shows the Krupp system of breech-loading. It consists of a round-backed wedge, which is pushed in from the side of the breech and forced firmly home by a screw provided with handles; the face of the wedge is fitted with an easily removable flat plate, which abuts against a Broadwell ring let into a recess in the end of the bore. On firing, the gas presses the ring firmly against the flat plate, and renders escape impossible as long as the surfaces remain uninjured. When they become worn, the ring and plate can be exchanged in a few minutes. The vent passes through the facing plate to the rear of the wedge. The gun is fired by a frictional vent-sealing tube, which is screwed by the fingers into the vent, and unscrewed after firing.

This form of breech-loading has a decided advantage in loading by hand at elevation, which may sometimes be required, as the weight of the wedge is not working against closing the breech, as in the case with interrupted screw systems. It has, however, several counterbalancing disadvantages; the handles at the side are very liable to be damaged by the enemy's fire or otherwise (in the heavy guns they are unshipped for firing); the length of the gun is necessarily greater in proportion to the length of bore; the recess for the Broadwell ring somewhat weakens the wall of the chamber; the gun can be fired even though the wedge is not pushed properly home, and the breech has to be opened after a missfire, or if the tube is exchanged without opening the breech, it may be unsafely replaced; moreover, the longitudinal strength depends on the soundness of the single piece of steel through which the wedge passes. Still it must be admitted by all unprejudiced persons that the Krupp ordnance, taking system, construction, and material altogether, are not easily to be beaten.

Diagram 3 shows the French marine system. Here the bore is continued to the rear extremity of the piece, the breech-end forming an intermittent screw—that is, a screw having the threads intermittently left and slotted away. The breech-block has a similarly cut screw on it, so that when the slots on the block correspond with the untouched threads in the gun, the block can be pushed straight in, and the threads made to engage by part of a revolution. In the French marine the escape of gas is stopped very much as in Krupp's system; a Broadwell ring is let into a recess in the end of the bore, and a plate on the face of the breech-block abuts against it. The vent bush passes through the screw, and is fitted with a lock at the rear for firing percussion tubes. It is so arranged that the gun cannot be fired unless the breech-block is screwed properly home. The parts are all protected behind the gun, and the only disadvantage seems to be the recess required for the Broadwell ring, which weakens the wall of the chamber and necessitates a corresponding increase in the area of the face of the breech-screw upon which the gas acts, thus increasing the longitudinal strain beyond that unavoidably due to the size of the powder-chamber.

As in Krupp's guns the parts liable to wear are very dependent for their duration on cleanliness and freedom from dust and grit, but when worn they are quickly and easily replaced.

Diagram 4 shows the French land service system. Here we have the interrupted screw as in the marine, but the escape is sealed in quite a different manner. A stalk passes through the breech-block, its foot being secured on the exterior. The stalk has a mushroom-shaped head projecting into the bore. Round the neck of the stalk, just under the mushroom, is a collar or pad of asbestos secured in a canvas cover. When the gun is fired, the gas presses the mushroom against the asbestos collar, and squeezes it against the walls of the bore. It is found that this cuts off all escape.

In this obturation we have no weakening of the walls of the gun, and no increase of longitudinal strain, but the bore is slightly shortened by the protrusion of the mushroom head into the chamber.

Its great advantages are that the soft pad adapts itself to the gun surface, against which it presses, regardless of dust, grit, bruises, or other imperfections. The parts can be replaced easily and quickly; they are also light and inexpensive.

The vent passes through the mushroom head and stalk to the rear, and the gun is fired by a simple friction tube, pulled from the side. This arrangement is defective, as the gas soon wears out the vent, necessitating a new mushroom; while the frame of the firing tube is blown forcibly out, clinging to the hook of the lanyard, and proving a source of inconvenience to the firer.

Diagram 5 shows the Elswick system, which consists of a flat-backed cup abutting against the slightly rounded face of the breech block. The lips of the cup rest against a copper ring let in the walls of the bore. On firing, the gas presses back the cup against the rounded end of the breech-block, and thus forces the lips hard against the copper ring.

The cup takes up very little room in the chamber, but is very sensitive to grit and dirt, so that, as well as the copper ring, it requires renewal at uncertain and often frequent intervals. The cup itself can be replaced in a few minutes, but the copper ring takes several hours to extract and renew; the instructions given lay down that a special cup is to be inserted, and two rounds fired with it so as to fully expand the ring, which is then to be trimmed to fit the reserve cups.

The firing arrangement consists of a removable needle-holder, which carries a percussion tube nearly to the end of the bore; the needle passes from the tube to the rear of the breech-block, and is there struck by a hammer actuated by a lanyard. There is a safety arrangement which prevents the hammer from striking the needle till the breech is properly closed. The chief objection to this plan of firing lies in the difficulty of training men to pull the lanyard in such a way as to give sufficient force to ignite the detonator.

Diagram 6 shows the breech action we began with, viz., the French interrupted screw. The Elswick obturation was selected. I do not know exactly why, but I believe under the idea that the gas would not be able to eat its way between the cup and the copper ring, which therefore would never require to be taken out and renewed. We changed the firing arrangement to one having a removable vent head carrying a friction tube: it was provided with a safety arrangement which prevented the lanyard from being hooked to the tube till the breech was properly home. As experience showed that the copper ring did require to be renewed from time to time at very uncertain intervals, and as this was a serious operation, experiments were forthwith instituted with the De Bange obturation, and with such success that it speedily established itself, and was adopted for all the new guns.

Diagrams 7 and 7A show our present breech-closing arrangement as applied to the steel 6- and 7-inch guns.

It has one great theoretical defect, it appears extremely complicated. This, however, is not quite so serious as it seems at first sight, for not only is it difficult for the parts to get out of order,

but any or all of them can be exchanged in two or three minutes as the fittings are all held together without any screws. The vent passes through the mushroom and stalk as in the French land service guns; a clutch box on the rear end of the stalk carries a percussion lock similar to that of the French marine. The safeguards which cause the apparent complication of the action are numerous. The tube cannot be struck by the hammer, even though the lanyard be pulled, till the breech is screwed home. Should there be a missfire, the slide is drawn back to permit the exchange of the tube, and the new tube cannot be fired till the slide is pushed properly over the tube again. Should the slide not be properly pushed over the tube before loading, the action of closing the breech forces it home; but should the tube be sticking so far out of the vent that forcing the slide home would break it and perhaps explode the detonator, the slide yields, and the attempt to screw the breech-block home reveals the error. Should the thumb slip in cocking, the hammer will not fall on the striker so as to explode the tube, but on a projection which is removed when the lanyard is pulled.

Thus, by coming last, we have been able to select and combine the best features of the French systems, land service and marine, making perhaps a few trifling improvements of our own.

The next point is construction.

The experimental breech-loading guns first designed followed implicitly the system of construction which owed its origin to Sir W. G. Armstrong, and which, though subsequently modified in several ways in the Royal Gun Factory, will ever be associated with his name. This was the system of wrought-iron coils shrunk over each other and lined with a steel tube, which had been adopted for the long discarded vent-piece breech-loaders, and afterwards for the muzzle-loaders up to and including the 80-ton and 100-ton guns. This construction had a long day of success, and its cult was not rudely disturbed till the close of the seventies. Early in the eighties—the revolutionary eighties—however, it was found impossible to vie any longer with the stronger material which was in general use in Germany and France. Guns of wrought iron could not be made to possess the same power as guns of steel without an important excess of weight.

Efforts were made to preserve the advantages of the coil construction by employing a mild steel largely alloyed with manganese, which could be made to weld satisfactorily, and experiments were carried out in the Royal Gun Factory with wrought-iron coils, steel coils, and forged steel hoops. These resulted in the complete victory of the forged steel hoops, and in April, 1882, the first English heavy breech-loader, entirely of forged steel, a 12-inch of 43 tons, was proposed by the Royal Gun Factory.

The matter was so important that it formed the subject of an elaborate inquiry by the Ordnance Committee, who took evidence from the principal experts of the country, and whose recommendations have proved of great value to the Service. They decided upon a general type of gun, which was based upon a design submitted by the

Royal Gun Factory on the 21st July, 1882, and all the guns since made for the British Government have conformed substantially to this type. But before describing it, I will take some of the Continental guns, the constructions of which are earlier in date.

Diagram 8 (Plate XXV) shows the outline of the 71-ton Krupp gun of 1881. The great German manufacturer keeps the sections of his guns a profound secret, and hence the drawing I am going to point to next, Diagram 9, must not be taken as authentic. During a visit to Essen in 1881 I saw the parts of his guns in the machines, and lying about, and I hope he will forgive me for having taken furtive measurements with an umbrella and by the eye, sufficient to enable me to make a tolerably close guess at the construction.

It should be said here that the Russian heavy guns are either made by Krupp on designs of similar character to this, or copied by the Russians in their own steel.

Krupp's latest design is for a heavy gun weighing 119 tons, and 35 cals. long, *vide* Diagram 10, which shows the authentic outline of this grand weapon. I venture to fill in the construction in Diagram 11, on the assumption that no radical change has taken place in the Essen principles since 1881, but again this must be taken as guess-work as regards the actual dimensions of the parts.

This is the heaviest gun in the world, and four are being made for the Italian land service.

It will be observed that the tube forms a lining extending from the muzzle to the face of the wedge, and that it is recessed at the end of the bore to receive the Broadwell ring. Over the tube is shrunk the breech-piece in which the wedge plays. Over the breech-piece are shrunk several hoops. Every portion is made of the finest gun steel.

In this construction the whole of the metal over the powder-chamber comes into play to sustain the transverse strain, which is transmitted from the tube to the breech-piece, and from the breech-piece to the superimposed hoops. Neither hoops nor tube, however, assist in bearing the longitudinal strain, which is entirely taken by the breech-piece. I suppose Krupp has satisfied himself that this gives plenty of strength, and that there is no chance of a dangerous defect, but I confess I should prefer to have a second string with guns of such great size in case anything went wrong with the breech-piece.

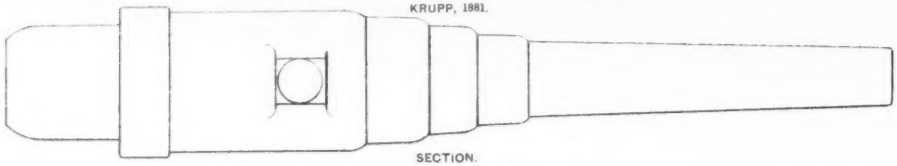
Diagrams 12 and 13 show the construction of the latest heavy French naval guns, the 34-cm. and 37-cm. of 52 and 71 tons respectively, proposed by General Dard, the great French artillerist.

The 34-cm. gun consists of a very thick tube or body strengthened with layers of hoops. As in Krupp's guns, the whole of the metal comes into play transversely, but the longitudinal strain is taken by the tube alone. Personally I do not like this construction. I think too much depends on the tube, and any failure of this part, which is moreover specially subject to the erosive action of the gas, would be disastrous in the extreme. Whether General Dard found it difficult to obtain satisfactory forgings big enough to make the 37-cm.

OUTLINE.

VIII. 40 c/M (15.75 INCH) B.L. GUN. 71 TONS.

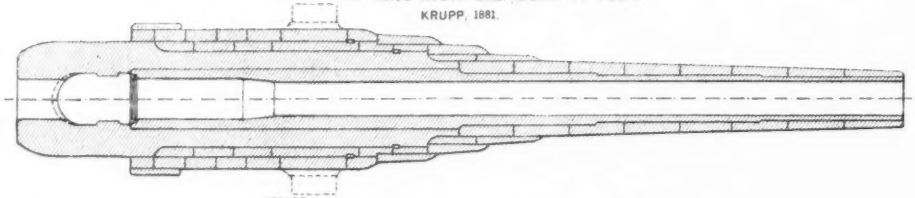
KRUPP, 1881.



SECTION.

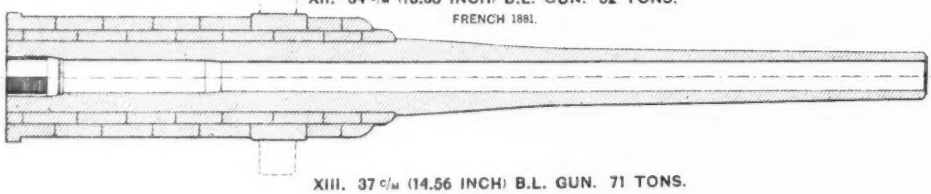
IX. 40 c/M (15.75 INCH) B.L. GUN. 71 TONS.

KRUPP, 1881.



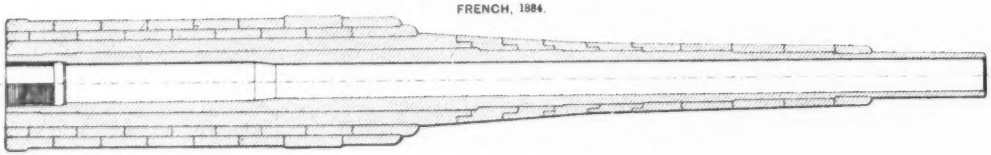
XII. 34 c/M (13.38 INCH) B.L. GUN. 52 TONS.

FRENCH 1881.



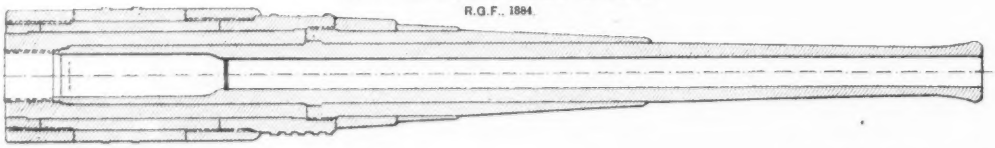
XIII. 37 c/M (14.56 INCH) B.L. GUN. 71 TONS.

FRENCH, 1884.



XVIII. 13.5 INCH B.L. GUN. 63 TONS.

R.G.F., 1884.

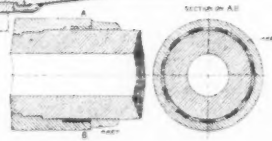


XV. 8 INCH B.L. GUN. 12 TONS.

TYPICAL DESIGN SUBMITTED TO ORDNANCE COMMITTEE BY BY R. G. F.

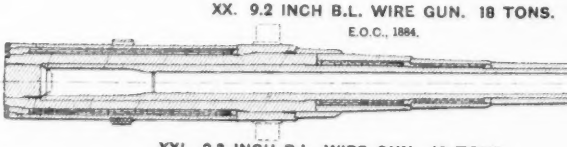
JULY 21ST, 1882.

XIX



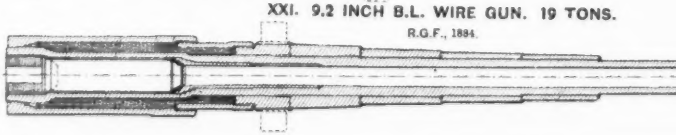
XX. 9.2 INCH B.L. WIRE GUN. 18 TONS.

E.O.C., 1884.



XXI. 9.2 INCH B.L. WIRE GUN. 19 TONS.

R.G.F., 1884.

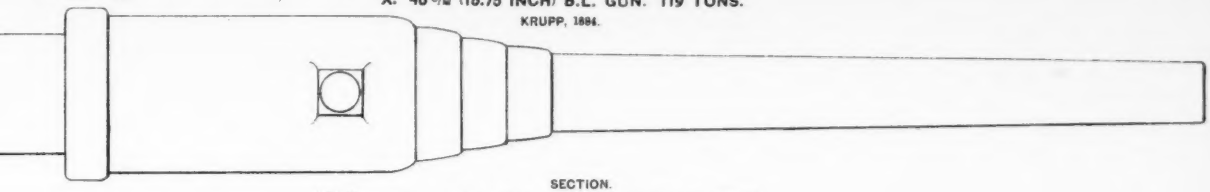


Scale 1/75

OUTLINE

X. 40 c/m (15.75 INCH) B.L. GUN. 119 TONS.

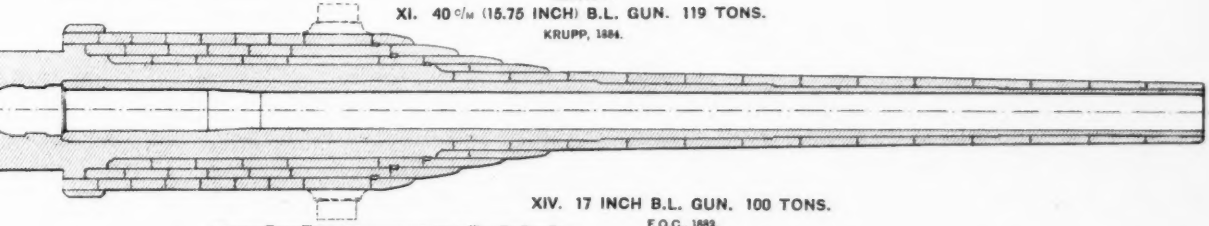
KRUPP, 1884.



SECTION.

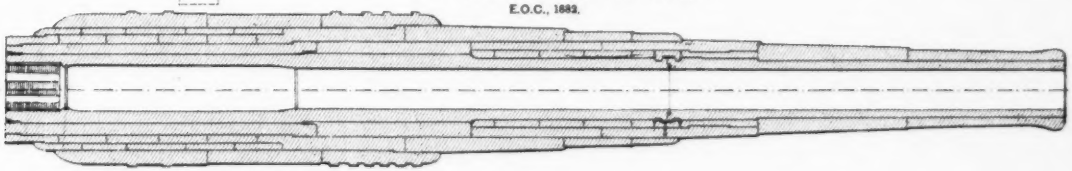
XI. 40 c/m (15.75 INCH) B.L. GUN. 119 TONS.

KRUPP, 1884.



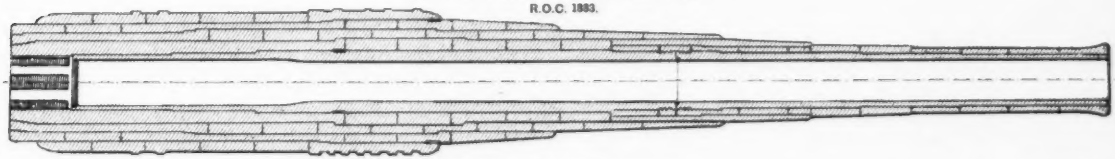
XIV. 17 INCH B.L. GUN. 100 TONS.

E.O.C., 1882.



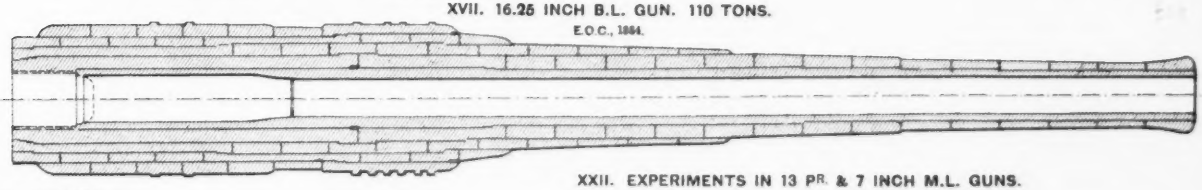
XVI. 17 INCH B.L. GUN. 102 TONS.

R.O.C. 1883.



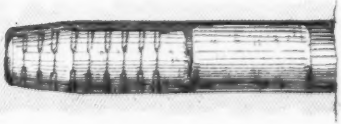
XVII. 16.25 INCH B.L. GUN. 110 TONS.

E.O.C., 1884.



UN. 18 TONS.

9 TONS.



XXII. EXPERIMENTS IN 13 PR. & 7 INCH M.L. GUNS.

WITH CHARGES OF LOT 116 R.L.G. 2 POWDER AT UNIFORM DENSITIES.

		13 pr.	7 inch.
Diameter of chamber		3.15 inches.	7 inches.
Length " "		18.7 "	18.7 "
Weight of charge		3 lb. 14½ oz.	20 lb. 3 oz.
" " projectile		13 lb.	115 lbs.
" " column of projectile per square inch		1.9 lb.	3.93 "
Pressure	1st round	26.3 tons.	22.1 tons.
	2nd "	29.4 "	23.4 "
	3rd "	37.6 "	30.7 "
	4th "	40.0 "	

guns on the same construction I do not know, but Le Creusot and St. Chamond can turn out forgings of 70 or 80 tons weight, and therefore I am inclined to suspect that General Dard preferred to trust less implicitly to the tube in these larger guns, and therefore thinned down the central forging and introduced a breech-piece between it and the hoops, which to my mind is a very decided improvement, as being put on with shrinkage it places the metal in a better position for resisting the transverse strain, and affords far greater security against longitudinal rupture. Every part is of steel.

Diagram 14 shows the Italian naval 100-ton breech-loader of 1882, manufactured by Sir W. G. Armstrong, Mitchell, and Co., of Elswick.

In this construction the tube is in two parts, held together longitudinally by a key-ring in halves. The breech-screw plays in the tube, over which is shrunk a steel breech-piece supported by two layers of thin hoops, and a thick outer wrought-iron coil. The middle and forward parts of the tube are supported partly by steel hoops and partly by wrought-iron coils. This construction was never repeated, though the experiments with it at Spezia were very successful. It is introduced here as showing with remarkable clearness the nature of the transition which has been taking place in construction.

I now give you, in Diagram 15, the typical design submitted to the Ordnance Committee by the Royal Gun Factory on 21st July, 1882, and recommended by them to guide future manufacture. This particular gun weighs 12 tons, and is 8 inches in calibre. Here the tube is thin and extends to the rear only sufficiently far to receive the obturator. Over the tube is shrunk a breech-piece, which is supported by exterior hoops. In this construction the whole of the metal assists in bearing the transverse strain, but the breech-piece does all the longitudinal work. This is not particularly objectionable in a medium sized gun of 12 tons, but would, I think, be so in very large ordnance; as you will presently see, with our heavy guns further provision is made for taking the longitudinal strain. The tube which is subject to erosion by gas is relieved from longitudinal strain, and is moreover so thin that a crack in it would not imperil the safety of the gun; while the form given to the breech opening renders it easy to bore out the eroded surface after long continued firing, and to insert a thin lining into the tube itself, as shown by the dotted lines, thus giving the gun a fresh life. With breech-loaders on the interrupted screw system, the longitudinal strain is found to act most dangerously about the position of the front threads, and it will be seen that at this point the metal of the breech-piece becomes thicker and stronger than in the more forward part over the chamber, while a strong hoop extending to the extreme rear of the gun clasps the breech-piece tightly over the screw, and prevents any tendency to open.

Diagram 16 shows the Armstrong 102-ton guns now being made for the "Lepanto," the great Italian war vessel. This design has

superseded that given on Diagram 14, and has been kindly sent to me by Captain A. Noble.

In Diagram 17 we have the section of the Elswick gun of 110 tons. This magnificent piece of ordnance is being manufactured for the British Government at the works of Sir W. G. Armstrong, Mitchell, and Co., Newcastle-upon-Tyne. It is entirely of steel. The tube is thin, and extends only to the obturator, and the breech-screw works in the breech-piece, which is shrunk over the tube as in the typical design on Diagram 15. Three layers of hoops reinforce the breech-piece. Here also every part of the metal over the chamber assists in supporting the transverse strain. The breech-piece is assisted in supporting the longitudinal strain by the peculiar distribution of the hoops. A long hoop provided with stout shoulders forms the rear part of the first layer. Its front shoulder engages the rear shoulder of a long hoop, which forms the front part of the second layer and carries a front exterior shoulder against which the trunnion hoop, forming the middle part of the third layer, abuts. Hence we have a direct pull from the trunnion hoop to the shoulder on the breech-piece. For the sake of clearness I speak of the trunnion hoop, but in reality there are no trunnions, the exterior of the hoop forms two rings which are held in a strong band attached to the slide.

To prevent the inner tube from moving forward in case the friction between it and the breech-piece should become relaxed on firing, a metal of the character of phosphor-bronze is run into a serrated recess at the front of the breech-piece.

In building up this gun the trunnion hoop forms a kind of water-shed, so to speak, that is, all the hoops behind it are put on from the breech, and all in front of it are put on from the muzzle. To assist friction in keeping them in place, phosphor-bronze is run into a serrated recess under the trunnion hoop. It will be observed that in this design several important improvements have been made in the 100-ton gun manufactured for the Italians in 1882, and shown on Diagram 14. Diagram 16 shows an intermediate step in the transition. The tube is thinned down and fitted into the breech-piece which receives the breech-screw. The joint in the front part of the tube is got rid of. The material of the gun is entirely of steel, cast and forged. The system of obturation is changed from the cup to the pad, and the powder-chamber is made shorter and thicker.

Diagram 18 represents the section of the 63-ton guns now being made in the Royal Gun Factory. They are entirely of forged steel, which, with the exception of some of the smaller parts, comes in the rough state from Sir J. Whitworth and Company, who have, so far, met our requirements better than any other maker. In this design the tube is thinned down at the breech, and the breech-piece, which is shrunk over it, receives the breech-screw, as in the typical gun of Diagram 15. The metal is disposed in fair conformity with the transverse strain expected, and considerable weight is saved in front of the trunnion ring. All the metal assists in taking the transverse strain, except a very small layer of which only half assists, as will be seen presently. Over the breech-piece a hoop extending the full length of the

chamber is shrunk on, and the weakness of a joint at this important part is avoided. An exterior hoop of fair length reinforces the breech still further. You will observe a novel feature in the disposal of the hoops, so as to secure the greatest amount of longitudinal strength.

Diagram 19 represents on a larger scale the manner in which hoops which abut against one another endways are linked together by outer hoops. The exterior of the inner hoop carries a ring which is slotted away so as to leave alternate projections and intervals. The interior of the outer hoop carries a corresponding ring, which is also slotted away so as to leave alternate projections and intervals. The outer hoop, expanded by heat, is passed over the inner hoop, so that the projections pass through the intervals; it is then turned so as to bring the projections of one hoop exactly in line with the projections of the other, thus preventing any longitudinal movement. The intervals are then filled up with long steel wedges, which are forcibly driven in. One wedge would be sufficient to prevent any circumferential shift, but all the intervals are filled up so that the strain from the interior on firing is directly transmitted to the whole of the outer hoop. You now see that half the metal of the layer represented by the thickness of the wedges is not available for resisting the transverse strain. This is made up by slightly increasing the thickness of the outer hoop. By this device the gun is stiffened at the joints, and held together longitudinally from the extreme breech end to a point far up the chase—an advantage in point of strength and safety possessed by no other design with which I am acquainted.

Coming last to steel breech-loaders, England has been justified in fearlessly adopting the metal which has been thoroughly tested by German experience. She has also adopted a construction which bears a certain similarity to the French, but is modified somewhat as in Krupp's guns.

Having thus taken what seemed to be best of other people's, we have added a little of our own in the matter of locking all the parts of the gun together. It would be unpardonable in a manufacturer not to adopt what he thought the best, and if I saw anything which satisfied me better than this 63-ton design I should certainly try to get it; hence you will, I am sure, pardon me for saying that I think that coming last we really have got the best forged steel construction known.

I use this expression to avoid including constructions which involve the employment of wire, which may perhaps supersede those consisting entirely of forged steel. It is perhaps hardly correct to include them among the guns of 1884, as they are chiefly experimental, but I believe some have been made and actually issued for service to Chili by the firm of Sir W. G. Armstrong, Mitchell, and Company.

Competitive designs have been prepared for the War Office by the same great firm and by the Royal Gun Factory for guns of this kind, and I have received Captain A. Noble's kind permission to show you on Diagram No. 20 a section of the 18-ton wire-gun proposed by

Elswick. The tube is thinned down inside the breech-piece, which is shrunk over it, and receives the breech-screw, as in Diagram 15. Instead of being reinforced with steel hoops the breech-piece receives great transverse support from a steel flat wire or ribbon which is wound round it like thread on a reel, but at considerable tension. This wire breaks at 60 tons per square inch. Thin protecting hoops of steel cover the wire and form the exterior of the gun. Here all the metal over the breech assists in supporting the transverse strain, but the longitudinal strain falls entirely on the breech-piece. The great obstacle to the employment of wire in a gun has always been the difficulty of getting sufficient longitudinal strength; no means have yet been devised of putting on high class wire to give both longitudinal and transverse strength. A portion of the wire may be put on, as was done in one construction most ingeniously by Sir W. G. Armstrong, so as to give longitudinal strength, but then it becomes useless transversely. That device has been abandoned in this design, and hence the longitudinal strength is rather low.

The Royal Gun Factory design submitted at the same time is shown on Diagram No. 21. In this construction the tube extends the whole length of the gun, and receives the breech-screw. It is protected from the erosive action of the gas by a thin lining, which extends from the obturator as far as necessary up the bore. The breech end of the tube is much thickened over the breech-screw, so that this is the strongest part longitudinally. Over the chamber is wound a high class flat wire, which confers immense transverse strength, but does nothing longitudinally. This wire breaks at 100 tons per square inch. Over the wire are shrunk two long hoops of forged steel, which transmit the longitudinal strain from the rear end of the tube to the trunnions, by means of two systems of locked projections.

In this construction the whole of the metal over the chamber assists in supporting the transverse strain. The longitudinal strength is divided about equally between the tube and the outer hoops, and is ample.

In considering the probability of forged steel constructions being supplanted by those containing wire, it must be borne in mind that the lighter the gun in proportion to its power, the more work is thrown on the carriage in checking and absorbing the recoil.

There is some doubt whether a practical limit has not already been reached in this respect with the latest patterns of forged steel guns; that is to say, any further reduction of weight in proportion to power may be found to necessitate more than a corresponding increase of weight to the carriage. Should experience prove this to be the case, there will be little advantage in the introduction of wire except in certain special cases, such as siege howitzers, &c.

Our third and last point of comparison is the power developed by the various types of ordnance which have been brought before you. In this respect we have had nothing to learn from abroad. We owe much to the labours of the Explosives Committee, and much to the admirable experiments with fired gunpowder in closed vessels which were carried out in 1874 by Captain A. Noble of Elswick and Sir

Frederick Abel, but our chief superiority is due to the practical results obtained with enlarged powder chambers and lengthened bores during a searching trial at the Royal Gun Factory in 1873; from these causes our ballistic knowledge has long been fuller and more complete than that of any of the Continental authorities; and it was really owing to this circumstance that England's guns held their ground as long as they did under the double disadvantage of being wrought-iron muzzle-loaders instead of steel breech-loaders.

The principle of chambering, that is of enlarging that part of the bore which contains the explosive, depends upon a peculiarity in the action of powder charges which is not very generally known or understood. I will endeavour to make the facts clear to you. Let us now turn to Diagram 22. Supposing I fill a chamber which measures 3·15 inches in diameter and 18·7 inches in length with R.L.G.^{2} powder, at a density of 35·6 cubic inches per lb., as in the proof charge of the 13-pr. M.L. field gun, the pressure will be extremely capricious, varying from about 26 tons to 40 tons per square inch; the velocities will vary also, but to nothing like the same extent.

Next, supposing I fill a chamber which measures 7 inches in diameter and 18·7 inches in length with 20 lbs. 3 ozs. of R.L.G.^{2}, at the same density as before, as in the 7-inch M.L. gun, I shall get fairly regular pressures and velocities; the pressures will be about 22 tons only, varying about a ton above and below, although the densities of the charges are equal, and there is more than five times as much powder in the charge which gives the lower pressure.

This anomalous result arise from the shape of the chamber. It is found that long narrow chambers favour the development of "wave pressures," as they are called, in a surprising degree, and experience has clearly shown that to get the best effect out of the charge, the chamber should not be longer than from three to four times its diameter; with a powder which is slow in proportion to the size of the gun, it is generally safe to approach or possibly exceed four diameters in length; but with a powder quick in proportion to the size of the gun, it is often dangerous to exceed three diameters in length.

The cause appears to be that as soon as the charge is lighted, the gas first evolved travels through the chamber from end to end with great rapidity, and sets up a dynamic action of a vibratory or wave character. But if it is asked why increasing the diameter of the chamber should mitigate and indeed remove this action, I have to confess frankly that I do not know. In the cases given in Diagram 22, the gas has just as far to travel, and to acquire momentum in, but it seems to lose the intensity of its rush from end to end when afforded increased space laterally.

Many efforts have been made to overcome this difficulty and to obtain satisfactory combustion in long narrow chambers by means of extensive air spacing, or by introducing central tubes of zinc and other substances, but the results have not been very promising, and in the Royal Gun Factory we have kept all our chambers short and thick, so as to consume the charges under the most favourable conditions.

There are also certain incidental advantages in shortening the cartridge by chambering; the length of travel of the projectile and consequently its velocity at the muzzle are increased. The shell has not to be rammed so far in, and the cartridge is more compact and serviceable. The disadvantage lies in the necessity for making the gun stronger and therefore heavier over the powder charge; in fact the breech must be that due to the size of the chamber and not of the bore. Still the ballistic advantages outweigh this, and as you see by the following table (p. 709), the chambered guns beat all others in energy per ton.

There is one more point where chambering will probably prove of great service. The special duty of all very heavy guns, either for land or sea service, is to get their projectiles through armour. Of late years the armour question has undergone very great change. The guns easily mastered the wrought-iron plate armour of the seventies, whether solid or in layers, but the use of steel which has become general in the eighties, has checked the artillerist's victorious career. Plates made either entirely of steel or of wrought iron faced with steel—the plates known as "Compound"—are very difficult to get through or to smash, if thoroughly well supported by firm backing. They break up the chilled iron shot, which splash harmlessly on the surface, while the steel shot fired at them usually break if too hard, or flatten out if too soft. We are trying to find the shot material which will prove most effective against this improved armour, and till this is accomplished we shall be unable to say with certainty what proportions should be given to the projectiles. The smashing or racking effect of a very heavy projectile of large diameter, striking with moderate velocity, may prove more effective than a lighter shot of smaller diameter and high velocity, or the reverse result may take place.

We can adapt our chambered guns to suit either scheme. Since the calibre does not bear any fixed relation to the diameter of chamber, we can either enlarge the bore, or reduce it by a thin lining, at pleasure, without interfering with the powder charge or its stronghold.

To recapitulate the principal points alluded to in this lecture, having come last among the Great Powers to steel breech-loaders, we have been able to select the best points from the various systems worked out by others. The material is that proved admirable chiefly by German experience; the system of breech-loading is that of the French land service; some parts of our present construction have been tested in Germany and some in France, while we have been able to improve on both, and solidify the whole structure in a marked degree. Not being hampered by the necessity for utilizing old material, we have been able to devote all our energies to new guns of the best quality, instead of repairing and altering old guns of inferior type, as is being largely done all over the Continent. We have, moreover, greatly extended the ballistics of our guns, and have conferred on them unsurpassed power in proportion to their weight.

It is true that in numbers we are behind, but having the best

Comparative Table of Powers of B.L. Guns, 1881–1884.

Nature of gun.	Date.	Weight of gun.	Weight of charge.	Weight of projectile.	$\frac{aC}{aB}$	$\frac{W}{D^3}$	Muzzle velocity.	Muzzle energy.	Perforation of iron at 1,000 yds.	Energy per ton of gun.
		Tons.	Lbs.	Lbs.	Ratio.		Ft.-secs.	Ft.-tons.	Inches.	Ft.-tons.
French, 34-cm. (13″·38)	1881	52	362	926	1·07	·39	1,968	24,868	22·9	478
French, 37-cm. (14″·56)	1884	71	546	1,180	1·02	·38	1,955	31,272	24·5	440
Krupp, 40-cm. (15″·75)	1881	71	485	1,715	1·21	·44	1,703	34,502	23·8	486
Krupp, 40-cm. (15″·75)	1884	119	615	1,632	1·31	·42	2,017	46,061	29·2	387
Elswick, 17″	1882	100	772	2,005	1·34	·41	1,832	46,600	28·5	460
Elswick, 16″·25	1884	110	900	1,800	1·69	·42	2,020	50,924	30·5	513
R.G.F., 13″·5	1884	63	625	1,250	1·78	·51	2,050	36,415	28·6	569
R.G.F., 9″·2 wire	1884	19	330	380	2·32	·50	2,520	16,730	23·2	880
Elswick, 9″·2 wire	1884	18	200	380	1·85	·50	2,200	12,759	20·0	709

types, all that is required is money and a little more time. The money will no doubt be forthcoming at the good pleasure of the country, which must not hesitate to pay its war insurance. But time is more serious; a heavy gun cannot be made under about fifteen months, and the only way to economize in this respect is to put up sufficient plant to permit of a considerable number of heavy guns being under manufacture at the same time. This has been done to some extent, and the next two or three years will see us in a very different position as regards numbers. Still there is much more to be done, and I will conclude by earnestly representing that though sufficient confidence may not have been felt two or three years ago to justify the heavy outlay which was seen to be necessary to rapid re-armament, yet that now the time has arrived for the country to face the question seriously, to grant the money, and to push the manufacture.

The CHAIRMAN: My lords, ladies, and gentlemen, I must apologize for having kept you waiting for a few moments, but I was detained longer than I expected by having to answer some questions in the House of Commons. I had great pleasure in giving the permission which Colonel Maitland asked for, as the head of the War Department, to deliver his lecture upon a most important subject on which he was so well qualified to give the latest and fullest information. We have had a most interesting and instructive lecture from him, and it now, I think, only devolves upon me to invite—as I believe is the custom on these occasions—any gentlemen to discuss the subject under the usual rules of discussion which take place in this Institution. I would only add that I have had great pleasure in taking the chair on this occasion, as showing the interest which I feel in this most important question. I understood it would not be necessary, if other business should prevent my doing so, that I should remain until the close of the discussion—and I fear that there is official business which will make it necessary, both for Lord Northbrook and myself, and I am afraid also for Mr. Brand, the Surveyor-General of the Ordnance, to leave, if not at once, at any rate very shortly. I will therefore ask Mr. W. H. Smith to take our place.

Admiral VESEY HAMILTON, C.B.: There is always a difficulty in this Institution in getting some one to make the first move; I do so now, and I have nothing controversial to say, the subject, in the four years I have been away from it, having got beyond me—I may say as a naval Officer, however, it is a source of great gratification to me to know that we have a near prospect of our Navy being eventually armed in a manner equal to, if not superior to, that of any navy we are likely to encounter. Speaking as a naval Officer also—I do not think I am saying too much when I speak for others also—I think we have every reason to be thankful to Colonel Maitland and the department over which he presides, for the way in which during the last few years they have made up for the leeway we had undoubtedly made, and I hope every other department under the Surveyor-General will treat us equally well.

Admiral BOYS: I do not find myself capable of criticizing this lecture, but I am sure the interesting matter which it contains, and the care with which it has been brought before us, deserve our best thanks. With regard to the "leeway" mentioned in the lecture, and which Admiral Hamilton has referred to, I must make a remark, and to some extent perhaps make some little excuses. We all know in our system of Government there can only be a certain amount of money devoted to certain Departments, and therefore each Head of a Department must make the most of the money he has to deal with. Well now, those who have been in office know that the slightest alteration in any one item of manufacture connected with guns particularly, involves very heavy expenses indeed. I know that such a thing as an alteration in a projectile which, generally speaking, may be looked upon as a trifle only—just a change in this stud or that gas-check, when it is done throughout the

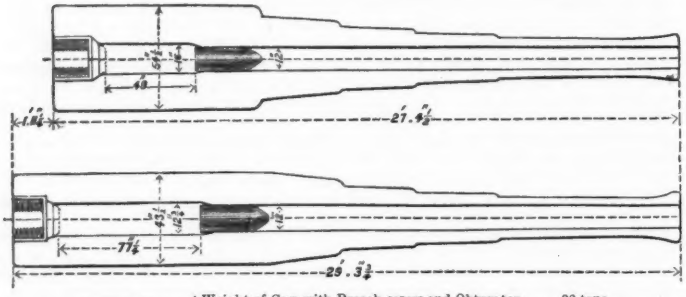
Service, involves an expenditure of thousands of pounds for the purpose. Therefore I think we are to be excused for objecting to the very material change which has now been found necessary in altering all our old muzzle-loading guns, which in their time were as good as any other nation possessed, to the present system of breech-loading without positive proof of the advantage to be gained. We may be excused for the delay that has occurred, and in consequence of that delay now I think we must probably have got a better weapon than we should have had without it. In proof of what the old muzzle-loader could do, I will only bring forward the case of the action at Alexandria. In that action there was not a single gun that was disabled from its own fire; that is, although some were afterwards condemned they could have continued the engagement if it had been required. This from our present experience is not to be expected from breech-loading guns. This may be called simply an excuse, but it is an extremely good reason for not launching into a new system without great consideration and experiment. With regard to the "energy per ton"—that is a most important point for the naval service. "Energy per ton" simply means the power of a gun in comparison to its weight; and in arming a ship the object is to get the greatest amount of work out of the guns she is to carry. On board ship every ton weight saved in guns can be added to armour or in some other way will tend to increase the efficiency of the ship. Perhaps Colonel Maitland will tell us what is generally considered to be the life of our breech-loading guns—I mean from the effect of erosion in the bore from firing large charges. He has told us—and I am very glad to hear it—that we can now repair our guns very easily by lining them and obviating the effect of erosion. With regard to the heavy nature of the new guns, what experiments have been made to show their power of endurance with heavy charges and the effect of continuous rapid firing? A few years ago we had an experiment with a 38-ton muzzle-loading gun at Shoeburyness, partly at my instigation, to try continuous rapid firing up to 200 rounds, as nearly as possible assimilating the conditions to those of an action at sea, firing as rapidly as possible for a quarter of an hour, then ceasing for a quarter of an hour, and so on alternately until 100 rounds were fired in one day; during the night re-venting the gun, and repeating the operation the next day. The gun stood the test satisfactorily. I would like to ask what experiments have been made in that direction with our new heavier guns so as to test endurance.

Mr. G. W. Rendel (Admiralty): The large and distinguished company assembled here to-day testifies to the interest felt in our artillery, and the importance attached to everything that may fall from the lecturer on this subject. I fully share that interest, and I trust that if I criticize anything advanced by Colonel Maitland, it will be understood that I do so in no controversial spirit, but to assist—as all who have studied the subject are bound to do—in forming correct conclusions on a matter of such high importance to the country as its artillery. On one statement made by the lecturer I for my part should like to have heard more detailed and exact explanations. I refer to the proportions which he laid down for the powder-chamber of our heavy guns. Colonel Maitland gives a rule for the proportion of the powder-chamber which in effect limits its length to $3\frac{1}{2}$ diameters; and I understand that he does so on the ground that if the length be made greater in proportion to diameter, there is a liability to dangerous wave-pressures in the gun. At the same time he states very fairly that an obvious result of this mode of proceeding is to oblige us to construct our guns over the powder-chamber with reference to the diameter of the powder-chamber and not to the calibre of the gun. He has carried the theory into practice in recent guns, and I may take as an example the new 43-ton gun.[1] In that gun the chamber has 16 inches diameter, the bore being 12 inches; consequently the strength of the gun over the breech has to be that adapted for a 16-inch calibre instead of only a 12-inch calibre. Now it may be said that although this is so, yet the gun is shorter and lighter on that account. But I should like to have seen Colonel Maitland's own estimate of the actual increase of weight involved by this rule. I myself have made a rough calculation, and I find that if the gun were made without an enlarged powder-chamber, leaving it identically the same from the base of the projectile forward and lengthening the rear to give the same volume of

[1] See Sketch annexed.

Diagram to illustrate Mr. Rendel's remarks on Colonel Maitland's Paper.

Approved 12″ Gun { Weight of Gun with Breech-screw and Obturator..... 43 tons.
,, Breech-screw and Obturator ..... 1,400 lbs.



Modified 12″ Gun { Weight of Gun with Breech-screw and Obturator..... 36 tons.
,, Breech-screw and Obturator ..... 710 lbs.

powder-chamber, you would have a diminution of weight from 43 tons to, I think, a little over 36. That is a very large reduction of weight of very great importance —at any rate to the Navy, where, as Admiral Boys has said, every ton we have to carry is of moment. If we save it in the gun we can put it into armour, speed, or some other form of efficiency. But Colonel Maitland says that if he diminishes the weight of the gun he thereby so increases the energy of its recoil that he would have to put into the mounting that which he saves on the gun. I think that statement requires to be confirmed by more exact investigation. The energies of recoil in the case I have assumed would be approximately in the heavier gun 275 foot-tons, and in the lighter gun, I think, something like 315. The increase no doubt involves some increase in the size of the hydraulic buffer in particular, but the change is accompanied with a diminution of the dimensions of the gun, because it is obvious that a gun of 16-inch calibre will have a larger outside diameter than one of 12 inches, and in point of fact the reduction of the outside of the gun is very considerable, viz., from 54½ inches to 43½ inches. To the Navy such a reduction of outside dimensions has special value, because we mount our turret and barbette guns generally in pairs. One of our reasons for doing away with trunnions was to enable us to place two guns as close as possible side by side. They now stand so close that they more resemble a double-barrelled gun than two independent cannon. This has two advantages: it diminishes greatly the couple tending to rotate the turret, a difficulty which abroad has led to the abandoning of double guns on revolving platforms; it also reduces the diameter of the circumscribing circle, and consequently has a tendency to reduce the size of the turntable and of the armour required to protect it. Therefore I think it may be found that instead of the diminution of the powder-chamber leading to an increase in weight of the whole system of mounting, it may do the reverse. Of course the argument on which the very large powder-chambers were adopted is correct as far as it goes. There is no doubt that wave-pressures have been found of a very violent character with quick-burning powder fired in chambers long relatively to their diameter, but I think there are plenty of experiments with slow-burning powder in which the proportions laid down by Colonel Maitland have been greatly exceeded without wave-pressure. In the 100-ton breech-loading gun made at Elswick and fired at Spezia in 1882, the powder-chamber is over five diameters in length, and the powder was fired from the end. Notwithstanding this there was no trace of wave-pressure at any time. That would tend to show that at any rate we need not fix a limit at 3½ calibres. Then again we have not seriously studied all the means by which we may hope to reduce those wave-pressures. I am not by any means satisfied that we have exhausted the subject of mode of ignition of the charge. The advantage to be gained by the diminution of

the chamber once admitted and appreciated we should be more likely to expend our ingenuity in getting rid of the difficulties of attaining that end, and therefore I think it unwise to lay down a rule on the subject with the authority which belongs to the position and ability of the lecturer. I may point out one more objection to the very large powder-chamber, namely, the large size and weight of the breech-screw which it involves, and which is of course particularly difficult to handle on a moving platform like that of a ship. In the comparison I have cited the weight of the breech-screw would be reduced one-half by the reduction of the powder-chamber, although of course that would be accompanied with the disadvantage that you could not put in a lining from the breech which Colonel Maitland mentioned as a possible means of repair.

Lieutenant-Colonel W. Hope, R.E.: I brought with me the official text-book on the construction of ordnance, and I came here prepared to demolish a good deal that I expected Colonel Maitland to say, but I am very glad to be relieved from the necessity of doing that owing to the very frank manner in which he has thrown the text-book overboard. There is scarcely a word in the text-book which he appears to agree with, although it is only dated 1879. He invited any one to explain, if they could, what produced the waves of pressure in long narrow powder-chambers, and I am very happy to be able to do that, and to tell him that I have successfully fired a cartridge of over 15 calibres in length in a powder-chamber 20 per cent. larger than the bore of the gun without bursting the gun and without setting up any wave-pressure; and I may say I accomplished that by lighting the powder not in two or three places, but in 140 places all at once. And alluding to what Colonel Maitland said as to the action of the powder after the shot began to move, I may say I first of all begin by moving the shot before I light the powder. Sir William Armstrong, some twenty-two or twenty-three years ago, tried to accomplish the same result of relieving the gun by moving the shot prior to the ignition of the powder, because no gun bursts except owing to some accidental flaw or some other such circumstances after the shot has once moved. It is in the short space of time that elapses before the shot moves that the gun bursts, and Sir William Armstrong tried drilling a vent immediately in the rear of the shot, but although he probably accomplished moving the shot first, he also accomplished an unexpected result, for he blew out his breech. And for this reason:—although we know now that gunpowder is not an explosive and does not explode, we still go on setting fire to it in the powder-chamber of the gun as if we still believed it was an explosive and did explode; in short, in the method of igniting the powder we have absolutely made no advance whatever since the battle of Crecy in 1346. That is a hard fact. Well, what happens when the Officer gives the word "fire" and the man pulls the lanyard is this: the friction-tube sets fire to the small portion of the powder immediately in front of the vent or underneath it, as the case may be, and that small portion of the charge is instantaneously converted into gas. The pressure due to that conversion depends upon the form and size of the grains of powder, but in the case of small-grained violent powder it would be in the neighbourhood of 42 tons to the inch. A differential action is at once set up in the powder-chamber; the front of the charge remains unignited while the rear is converted into gas. That gas is confined by the rigid incompressible walls of the gun, and unless it succeeds in blowing out the breech, the only escape for it is by driving out the projectile with which it is not in contact, and as the powder in front of it is compressible, it naturally succeeds in compressing, and very violently compressing, the unignited powder against the base of the shot. Now, if you compress a cubic inch of powder into half a cubic inch of space before you set fire to it in an enclosed chamber it will give exactly double the pressure that it would have given if it had not been compressed, and therefore in proportion as the charge of powder is long, and the powder-chamber long and narrow, if the powder is ignited in the usual way, the front of the charge is violently compressed against the base of the shot before the shot moves, and you set up a circumferential wave of pressure that nothing will stand.[1]

[1] The reader is referred for further explanations to Colonel Hope's paper on "A Revolution in the Science of Gunnery," read on the 23rd July, and which will be published in due course.—Ed.

Sir FREDERICK BRAMWELL, M. Inst. C.E.: I was very glad indeed to hear from Colonel Hope that he was about to solve the problem Colonel Maitland put to us, but I trust he will pardon me if I say I do not think he has done so. Colonel Maitland has put before us this problem, which seems to me, at all events up to the present, to be insoluble. There is Diagram 22 upon the wall. He says, "I put a cartridge of a certain length into a gun 3·15 inches bore, and having in front a projectile, also 3·15 inches diameter and of a certain length. Below this figure is that of the other cartridge, 7 inches in diameter, having a 7-inch projectile in front of it considerably longer than the projectile of the 3·15 bore. Each inch area therefore of the larger gun and the cartridge in that gun has got a greater resistance upon it than each inch area of the smaller cartridge, because the projectile is a longer one, and if it is solid the resistance will be in proportion to the length. Under these circumstances the small cartridge when fired gives pressures which vary from 26·3 up to 40 tons from the first to the fourth round, whilst the large cartridge gives 22, 23, 20. I think Colonel Hope's explanation would have been satisfactory if both these cartridges had behaved in the same way, that is, if it had appeared that a cartridge of a certain length always gave the same wave-pressure; but Colonel Maitland points out to us that it does not depend upon length, but upon length considered in its ratio to diameter; and I have failed to appreciate how that which Colonel Hope put forward as an explanation does explain that most curious fact. Colonel Maitland did not call attention to the fact in his paper to-day (but he was good enough to speak to me about it some time ago), that in the large guns there is a greater resistance per unit of surface on the powder; but I mentioned it as I think it should be kept in view as adding to the difficulty of the explanation. I must for one say I do not feel any shame in confessing—especially after Colonel Maitland's most frank and honest admission of his inability to solve the problem—that I have not the most remote conception as to why the length of the chamber relative to the bore should have anything to do with a variation in pressure. I can quite see why the actual length should, but why the relative length should is to me a mystery.

Mr. KRAFTMEIR: I should like to mention one point. Colonel Maitland referred to the improvement made at Waltham Abbey by the present superintendent of the manufacture of C_2 powder. In connection with this I may say that there has certainly been most astonishing progress made in the manufacture of powder. As Colonel Maitland said, "for certain guns a charge of 200 lbs. of C_2 powder would be required to give the same result as a charge of 170 lbs. of cocoa powder." I think that, taking into consideration the increased cost of the extra 30 lbs. of powder, the further weight of carriage, the considerably heavier cartridge, and the more difficult way of handling the same, it is of very great importance to adopt, if possible, charges which are lighter and yet give the same result. I believe that several English Officers are very much in favour of further experiments being made with brown prismatic powder, of which very large quantities have lately been ordered by most of the European Governments, and further believe that even the Superintendent of Waltham Abbey is in favour of this powder, and, as Colonel Maitland says, he hopes the Government will grant the necessary funds for the construction of guns, so I express also the hope that some further steps will shortly be taken with regard to the brown prismatic powder. Colonel Maitland mentioned that R.L.G.^{2} powder had given very irregular results in different powder-chambers. I believe that it is a powder which can certainly not be trusted to any great extent. I have been told that in some cases this powder has given up to 30 and more tons' pressure. There is a desire that a new powder should be made in place of the R.L.G.^{2}, and I should like to mention that the United Rhenish Westphalian Company is at the present moment engaged in adapting the brown prismatic powder for field artillery purposes. They have constructed small prisms of about half an inch in diameter and three-quarters of an inch in height. The experiments have so far been satisfactory, but they are not yet sufficiently advanced in order to bring the matter before the English Government.

Captain PALLISER: Colonel Maitland is to be congratulated on the success of his guns. I have long watched his exertions and progress with the greatest interest. It happens that the subject under discussion is of special interest elsewhere, for I

may mention a fact which, though of great importance, is probably new to many here: it is that the Canadian Government has suggested the erection of a gun factory at Quebec. I need hardly say this would be the first step towards establishing an arsenal in that fortress. Quebec will before long be connected by railway with Vancouver's Island, on the Pacific Coast, where our naval station is established, and where the great coal mines for our fleet are being worked. The suggestion, therefore, of the Minister of Defence is not premature. No Colony can be said to be out of leading strings until it has established an arsenal with the machinery necessary for the manufacture and repair of its weapons of defence. I have therefore received a request to furnish an estimate for a gun factory at Quebec in connection with the cartridge factory already established by the Government of the Dominion. My report will embrace the amount of subsidy required, the expenses of the establishment, and the amount of work it might be expected to turn out annually. It would be an exceedingly difficult operation for the Canadians to make guns if any great forgings were required to be made in their country, but the steel manufacturers of England turn out all portions of the guns rough bored and tempered, so that the defences of the Empire are now greatly facilitated by the mode of construction due to the great efforts of our friend Colonel Maitland. I have no doubt we shall soon find the Government of Canada with machinery sufficient to turn out a moderate supply of the new steel breech-loading guns, the same machinery being available for keeping their present armament in repair. Whether the other Colonies will follow this example, and thus greatly contribute to the defence of the Empire, remains to be seen.

Thursday, June 26, 1884.

The Right Hon. W. H. SMITH, M.P., in the Chair.

(Adjourned Discussion on Col. Maitland's Paper.)

Mr. Longridge, C.E.: In the first place, Sir, I cannot but feel considerable disappointment and a good deal of alarm at the general features of Colonel Maitland's paper. We have been accustomed to hear for many years that we had the very best artillery in the world. I remember that many times, when the Army and Navy Estimates were brought forward in the House of Commons, we were assured over and over again that our artillery was the very best in existence. I find in Colonel Maitland's paper an admission that since 1876 we have been lagging behind the rest of the world. That is not new to me; I was perfectly aware of that fact. But there is another thing which alarms me, perhaps, more than that, and that is, that our future progress in artillery appears to be dependent on watching the experience of other nations. Credit has been taken by Colonel Maitland for our having kept back, seeing what other people have done, and then adopting their improvements. Well, Sir, I think myself that it is very fortunate for the nation that we have not been "caught napping," and I should like to know what would be the consequence if within the next eight or ten years we should be "caught napping." We have heard from Colonel Maitland that to make one big gun is a matter of fifteen months. No doubt he coupled that with the assertion that, if the nation would find plenty of money and plenty of plant, we could make more great guns in the same time. I confess I look forward with very great dismay to the fact that in making these great guns we are to follow upon the lines of what other nations have done. I think myself that a country like this ought to lead the van. I think an establishment like Woolwich should not follow Krupp or Elswick, or the French; and I look upon the prospect with more dismay still, because I know that there is another system of artillery which is now at least coming to the front, and which, two years ago, Colonel Maitland himself said appeared to be a very dangerous rival to these steel forgings which he now praises so much. I know that the system of wire, which I have now advocated for pretty nearly thirty years, is being studied carefully by other nations. And I should be greatly dismayed, and I shall

not be much surprised, if we find that by the time we have got this new armament, on which we are asked to spend so much, we are told that it again is obsolete, and shall have to follow the other nations in the reconstruction of a wire gun armament. I know quite well it will be said that these are matters which cannot be done in a day, but it is two years since Colonel Maitland told us the subject was one which was attracting attention. What has been done since? What experiments have been made with the wire gun system since then? I happen to know pretty nearly what has been doing at Elswick; I know something of what has been done at Woolwich. I know the Ordnance Committee were instructed to investigate this subject, and I know the nature of the investigation they have made, and this knowledge does not lead me to look forward very hopefully towards our immediate future in wire gun construction. Having made these few general remarks, there are just one or two observations I should like to make with reference to some of Colonel Maitland's statements. I entirely disagree with Colonel Maitland in considering that we have made improvements in the powder. I am not alone in that. I am perfectly satisfied myself that slow-burning powder is not an improvement: it is a modification of the powder to suit the inherent weakness of our guns. I say it is just as much going back from what we ought to do, as it would be now if our great steam-ship companies were to go back to the low-pressure engine, where we were confined to 4 lbs. per square inch of the boiler. The results we have arrived at in steam navigation have been from the development of high pressure, and, weight for weight, a high-pressure gun will give a far higher result than a low-pressure gun. I point to that table with the utmost confidence. You have an energy of 880 foot-tons per ton of gun. I may say that that method of estimating energy is utterly fallacious, because I can make wire guns equally strong and very much lighter than these present guns, and I can develop 1,000 tons energy per ton of weight, but I know that to do so would be perfectly useless, you must have the weight to meet the recoil; therefore, although there are all sorts of appliances for meeting the recoil, yet, unless you take the questions of weight of gun-carriage and appliances altogether, a statement like that is perfectly fallacious. But I would take the gun by itself, and I am prepared to show that, instead of those guns with large chambers and large charges being lighter than others, they are a very great deal heavier than the high-pressure gun. Colonel Maitland states that doubling the pressure would increase the weight of the gun 80 per cent. I beg to say it would do nothing of the sort. I have shown in my "Treatise on the Application of Wire to Construction of Ordnance" that, weight for weight, I can make a 40-ton gun which I compare with a 40-ton gun of Sir William Armstrong, and the result is this, that if I am allowed to use powder giving 33 tons pressure instead of 21, I can get with 413 lbs. of powder an energy of 33,000 foot-tons; whereas the chambered gun, with 500 lbs. of powder, will not exceed 24,000 foot-tons, the guns being the same weight. There is no doubt, therefore, that weight for weight, if you have high pressure, you can get a very much more powerful machine. It is precisely the same in a steam-engine as in a gun; and I must take exception to one expression of Colonel Maitland's, in which he spoke of a thing being right in an engineer's point of view and utterly and entirely wrong in an artillerist's point of view. I cannot understand the difference. If he tells me the navigation of a ship is very different from making the engines, I agree with him, but he will scarcely expect the Captain of a ship to go and tell the engine-builder how thick his piston-rod is to be. It is exactly the same thing in a gun. A gun is exactly as much a machine as a steam-engine. The same mathematical rules of strain and proportion must be applied, and these are precisely those matters which are within the scope of an engineer; and therefore, if an artillerist is different from an engineer, let him tell tell us what sort of gun he wants, and then we will make one for him; but do not let him come to us and say it is not our business to make guns because we are not artillerists. There is another point connected with chambering which seems to be rather puzzling to Colonel Maitland, but I confess I can see no difficulty about it at all. The fact is simply this: that the pressure in a space like this (referring to Diagram 22), with a loaded valve upon it, which a projectile is, when the inertia of the valve is very great the pressure depends directly as the rate of generation of the gas, and inversely as the space it has to occupy. The ratio of generation depends

simply as the surface of combustion, that is, it increases directly as the radius; the space varies merely as the square of the radius. Consequently the pressure must be a function of the radius divided by the square of the radius, and therefore it follows necessarily that in the large gun you should have a lower pressure than in the smaller one. There are two fundamental differences betwixt myself and Woolwich and Elswick. The one is this question of longitudinal strain. I maintain, and have for years, that the materials to resist the longitudinal strain should be entirely independent of the material to resist the bursting strain. When you have that, you know the amount of each strain, and you can calculate accordingly. When you do not know it, when you divide the two by a haphazard system, it is impossible to tell how the strain will be apportioned between the two, and therefore I differ altogether from Colonel Maitland in thinking it is an advantage to divide the strain between the tube and the outer casing. He talks of having two strings to his bow: just as well might an engineer have two piston-rods to the cylinder of a steam-engine. You know the strain in both cases, and if you apportion the material to the strain you have no danger of failure; but if you divide it between two or more you introduce an element of very serious difficulty indeed. There has been no allusion in Colonel Maitland's paper to the very important question of the mode and pitch of rifling. We have heard a good deal about these, and I do believe myself they are of the very highest importance. I am sure the amount of rotation is a most important thing. My own opinion is, that Sir Joseph Whitworth, with his rapid rotation, is on the right track. But rapid rotation is required by a long shot, and requires a high velocity. High velocity cannot be obtained without high pressure except by these enormous charges, fully one-half the weight of the shot, involving an enormously long, cumbersome, expensive, and dangerous gun. I have no hesitation in stating that as my deliberate opinion, and that a lighter, stronger, and equally safe gun can be made in which no portion shall be strained more than in the heavy and low-pressure gun as now proposed if you take the pressures 30 and 35 tons per square inch, instead of 15 and 17, and with no more strain upon the gun; but, in order to do that, you must not go on making experiments haphazard, and without proper calculation as to how those strains will be distributed.

Captain R. Edmonds: I am one of the representatives of Woolwich, and therefore you will expect that I shall defend to a certain extent what we do at Woolwich. Mr. Longridge has just said that we have not the best artillery, that we are lagging behind other people, that we are following other nations. Now it appears to me we shall have some time to wait before we follow other nations with regard to wire as a material for guns. They have not gone into that subject any more than we have, although it has been before the public for nearly thirty years. Mr. Longridge does not give us the credit that he ought, with reference to our guns as far as strength is concerned. It is all very well to have a formula, and I admire formulæ as much as anyone, but it is expected that you will use those formulæ in the manner in which the authors have intended them. The formulæ of Hart, Lamé, Rankine, and Mr. Longridge himself all have reference to a cylinder filled entirely from end to end with an uniform pressure, and in which the ends are not supported in any way by any extraneous parts. I should like to know whether a gun is in such a condition when it is fired. A gun is a cylinder filled partially with a certain amount of pressure, and the two ends of the cylinder beyond the chamber, both front and rear, are adding very materially to the strength of the chamber itself. A gun in this condition resolves itself into a cylindrical beam from front to rear, in which the ends from the longitudinal tension may be considered to be firmly fixed; and for the purposes of calculation you may consider the beam to be divided into a number of longitudinal staves. Now those staves are giving a large amount of resistance to deflection, which is inversely as the cube of the length and directly as the cube of the height of the material brought into play. In our old guns the powder was strong; the charges were short; the guns were thick; consequently, you will find when you calculate these resistances that you get a large acquisition of strength from the resistance to deflection which the gun itself possesses. I think it is from this cause that when we had an experiment called the "crucial test" of the 9-inch muzzle-loading guns, in which the outside portion of one gun was in one thickness,

and the outside of the other in two thicknesses, the two guns went through the same test and were as nearly alike as possible. Each gun fired over 1,100 rounds. The one in one thickness, by theory, ought to have burst, but it did not, and I fancy that strength was in consequence of the increase of strength from its resistance to deflection. Again, recently a cast-iron gun all in one thickness, with the exception of the wrought-iron tube, was fired, and in the gun there were developed pressures of over 34 tons per inch. That gun, taking the ordinary theory with reference to cylinders, ought to have burst with a pressure of 30 tons. It did not. Why? I think because you had a short, thick, cylindrical beam, whose resistance to deflection was assisting the transverse strength of the chamber; you had this longitudinal deflectional strength added to the ordinary calculated strength. In a wire gun you get nothing of the sort. In a wire gun each little piece of the chamber stands upon its own merits; it gets no assistance from the wires at its sides, or anywhere else, and if it cannot do the work put upon it, it must give way. There may be differences in the pressures at different parts of the chambers from one cause or another. If the wire gun is not strong enough in that particular part where the maximum pressure is exerted, it has to yield, whereas in the case of a gun made in the ordinary manner, if a variation of pressure in one part of the chamber occurs, you will find that the material at both sides and top are all adding their assistance; they are doing their work unitedly, and they stand firm together. I think if you were to take a wire gun, and if you have the wire simply of the same strength as the ordinary steel of which we make guns, you would find that the wire gun would be a much weaker gun (although you might have it all strained to its elastic limit throughout the whole of the substance) than a gun made in two or three pieces, provided you put on the proper amount of shrinkage. Now a word or two about shrinkage. Mr. Longridge thinks that we people at Woolwich are benighted beings, and are perfectly ignorant of this question of shrinkage. These assertions are based on one or two quotations from the "Text Book on Ordnance." That book is not written for the purpose of teaching all the minutiæ with reference to the manufacture of guns; it is written as a general description of the process, and, moreover, I may say also that that book was not written by the people who made the gun, and that it is giving us very scant credit for taking any interest in our work to suppose that we have neglected the literature on the subject of the pressure of cylinders for the last thirty years. Surely if we are engaged all our lives in making guns we should take the trouble to look into these things. The first that I learned about this question of building up cylinders was from "Mallet on the Construction of Artillery," which came out in 1856, and which I had in 1860. Then in 1864 there was published a translation of a most elaborate German treatise. Then Lamé gives one article on the subject in his "Leçons." Rankine, in his "Applied Mechanics," gave a few formulæ, and also a diagram which shows how to get all the pressures and tensions in every part of a cylinder, and I may say from his formulæ and from that diagram I deduce everything that is necessary in the construction of guns, and to show in what condition every part of a cylinder is before and after shrinkage. I am now speaking with reference as to how one cylinder acts upon another. I say that from Rankine I deduce everything, even to shrinkage, which we are said to know nothing about. After that came Virgile, whose book was published in 1874. Mr. Longridge and others should give us credit for being able to look at these things for ourselves, and should consider that if we do not do exactly what he thinks is right, there may be some reason for our not doing so, and that if we be mad there is some method in our madness. Mr. Longridge says he thinks there ought to be one set of materials for the longitudinal strain, and another set to take the transverse strain. Supposing you have a piece of metal strained in one direction to its elastic limit, and that you gave it a strain at right angles to the former, I am not quite sure how far it is weakened, but I think I may say this: if you have an inch of metal which is to withstand a strain of 10 tons in a longitudinal direction, and you have another inch of metal which is to stand a strain of 10 tons in a transverse direction, that if you put those two pieces of metal together and then make the combined pieces take the same strain of 10 tons in one direction and 10 tons in the other, you will find that your resulting strain is something like 15 tons each way; but as the result you have 2 inches to stand the strain of 15 tons, instead of 1 inch to stand the

strain of 10 tons; therefore instead of your metal being strained to 10 tons, it is only strained 7½ tons. I mean to say that the metal of a gun should be arranged if possible in such a manner as to offer its quota of strength and resistance in every direction. Now look at this French gun—what you might term almost of a Mosaic pattern. Does not it stand to reason that if all these pieces were connected with each other they would be adding very much to the strength of the gun? A few weeks ago a French gun went. How? It broke through the middle and left the hoops standing. Had these exterior hoops been in one, I venture to say that gun would have remained intact. With reference to our guns of a long time ago, when we had such supposed bad guns—14 or 16 years ago—I think from the manner in which those guns were made that we had guns that were better than those of any other nation in the world. Our guns were standing while other guns were breaking; our guns had to stand the "brutale" powder, while Continental nations were going all round to get a milder explosive. We wanted to get more power, and when the powder was altered we made our guns longer. That leads me to another point. I have said several things against wire; now I may say one or two things in its favour. If wire is to be used in our guns—and I think it most likely will be—it will be in consequence of going in a direction quite opposite to that which Mr. Longridge advocates. He says, "Why not make a very strong gun, use very little powder, and have very little weight?" If you have very strong powder, the probability is the amount will be very small, and therefore the charge will be short, and in that case you get more resistance from a gun which is made in a very solid manner, rather than with wire; but if you have low pressures and long charges, I think the case is altered altogether. If you have a chamber double the length, and the walls are only half the thickness of another chamber, then the resistance to deflection of the first is only about one-sixty-fourth of what it is in the second, and therefore you can dispose of the material in a better manner, and you can use wire with advantage. I think if we make guns in this way most probably the wire will come into use. We can now get wire of which the limit of elasticity is something like 80 tons; that is to say, it does not receive a permanent set until you put a strain on it of 80 tons per square inch. The *modulus* of elasticity of the wire is very little more than that of the tempered steel that we use, which may be taken as 12,500 tons. The *modulus* of elasticity of this enormously strong wire is only 13,000 tons; but you have the elastic limit of 80 tons, and I think that with wire of that character it is probable that we shall be able to use it in the guns of the future. I have taken this opportunity of saying one or two things with reference to Woolwich, because the observations against us have been made so broadcast that I think we ought to be defended. We are not in the habit of defending ourselves at Woolwich, but I could not let this opportunity pass without saying a few words.

Captain NOBLE (Elswick): I agree with so much that Colonel Maitland has said in his lecture, that it may seem somewhat ungracious if the points that I select for remark are those upon which I have the misfortune to differ somewhat from him, or at least if I do not altogether differ—points upon which there is something to be said upon the other side. But before passing to those points let me say first, that I think that Colonel Maitland has very correctly formulated the properties that ought to be sought for in gunpowder to be used with the first-class guns in Her Majesty's Service. I think we may say, however, the properties to be sought for were as well understood fifteen years ago as at this moment, but that when the Committee of Explosives commenced their labours on this subject, they were utterly unable to obtain powder conforming to those conditions. Agreeing as I do with Colonel Maitland as to the share that this country has taken in developing the great strides which the science of ballistics has made during the last fifteen years, it is yet, I think, somewhat a subject for humiliation that the powder makers of this country have not been equally successful with those abroad. If we except a few experimental lots made by the Royal Establishment, the powders made by the makers of this country cannot, I think, compare either in quality or uniformity with the powders that have been in use in Italy, France, or Germany. I think also that Colonel Maitland, speaking with the high authority of his position and with his own personal experience, has done right to point out, as strongly as he has done,

the fallacy of the view urged by some, viz., that in order to obtain increased power from guns we ought to look to an increased maximum pressure in the bore. Colonel Maitland's comments are, I think, unanswerable, and if they were answered, I think others as cogent might be adduced. But I do not quite concur with the views Colonel Maitland has expressed with regard to the relative energies which are obtainable from muzzle- and breech-loading guns. If he means to say that with a given brand of powder higher energies are obtainable with a breech-loader in the case where a shot is held back until a certain initial tension is produced, I agree with him. Or again, if he says that a certain brand of powder which gives good results in a breech-loader, or with a projectile held back, does not give equally good results in a muzzle-loader, there again I agree with him. But if he means to say that results which are obtainable with a breech-loader taken with reference to a given pressure in the gun, or taken with reference to a given weight of the gun, are unattainable in a muzzle-loader, there I think I must venture to differ. I do not know that any experiments which have since been made would cause me to take different views from those which I expressed after making some experiments on this subject seven or eight years ago. In those experiments I allowed shot to start in their passage up the bore without being held back. I had others in which a driving ring of larger diameter held back the projectiles; in the latter case I obtained energies some 15 per cent. higher than in the former; but these energies were—as I think might be expected—obtained at the expense of a higher pressure in the powder-chamber. Sir Frederick Abel and myself commented on these experiments in a paper presented to the Royal Society in 1879, and as I have said, I have very little to add to what we there stated. If I refer to the pressure-curve which Colonel Maitland showed you the other day, it is obvious that if, taking the point in the bore where we may consider the charges practically completely burned in both guns, the portion of the curve from that point forward must in both breech- and muzzle-loader be considered identical. The higher energy obtainable with the breech-loader is therefore due to the higher pressure obtained in the anterior portion of the curve, and I cannot myself see that there is any difficulty in making the areas of the two curves equal, either by lengthening the muzzle-loader or by using a powder slightly more explosive (if I may use the word), and thus giving the same pressure in the muzzle- as in the breech-loader, or by adding to the charge, or by a combination of these methods, or in various other ways. That is the way in which the theoretical view strikes me, and I would only add that several years ago I fired charges of 100 lbs. from a muzzle-loader and a breech-loader, both 8-inch guns and with identical pressures in their chambers. These charges gave to 8-inch projectiles weighing 180 lbs. velocities which were respectively 2,092 and 2,096 feet per second; and these practical experiments seem to me to confirm the theoretical view which I, with all respect to the opinions of others, should almost hold to be unanswerable. I now come to the question of obturation. Colonel Maitland has chiefly dwelt upon two systems—the De Bange system and the Elswick system. Now I do not for a moment mean to say that either of these systems is a bad one,—on the contrary, I think that with both systems you can obtain a very good obturation. I venture to say, however, that with large guns at all events there has been more experience with the Elswick arrangement than with the De Bange arrangement. I have ascertained that in France there is little experience in the De Bange system of obturation with guns above 15 centimetres calibre. There is also another advantage in the Elswick system; it does not add to the weight of the gun, and it also does not take nearly so much power to open and close the gun as does the De Bange system. We have had occasion recently to work out the power necessary to open and close (I mean by hydraulic power) the breech of a 43-ton gun furnished with a De Bange obturator. We found about five times the power is necessary to open the 43-ton gun furnished with a De Bange obturator that has been found necessary with ease to open the 100-ton gun furnished with a Krupp obturator. But having said this, I wish it to be distinctly understood that I am stating the point simply as it occurs to me. Both systems I believe are capable of being made most efficient systems of obturation. I cannot say quite as much with regard to the firing arrangement in use in the Government guns. I think it is both more complicated and not quite

so safe as our system. In our system it is, I think, almost impossible that the men serving the gun can be injured by means of his primer. I should say, with regard to the violent effects that occasionally result from the rush of the gas up a long tube, that sooner or later an accident may occur with the primer placed at the exterior of the gun. But I am perhaps hypercritical, and I think I have omitted to mention a point of some importance as regards our Elswick obturator, and that is that I do not look upon the fact of having occasionally to re-copper the gun as quite so serious as Colonel Maitland seems to do. In all my experience I have only known re-coppering necessary four times—twice for the purpose of instruction simply, and twice because it was necessary. The operation also is not serious, not so serious as re-venting a gun in the old days, or at all events it does not take more time. The next point is as to the history of the construction, and I confess that if I had to write the story of the guns I should have used very different language from that which is used by Colonel Maitland, but points of this nature are interesting perhaps only to ourselves, and I merely mention this particular one in passing, because if I did not mention it, it might be thought that I concurred exactly with what is said. Such is not the case, but it is a much more pleasing task to me to say that if I take the broad principles of construction, leaving out minor matters of detail, that I, and speaking for Elswick I might say we, approve generally most highly of the system of construction now followed in the Royal Establishments. With regard to ribbon or wire construction, I must say that I think that when we have gained more experience this system of construction will be a very valuable one, or I ought perhaps to say "partial wire construction," because I fancy that it is always easier to obtain the longitudinal strength of the gun in other ways—in the way, for instance, in which we now construct a gun; and when we have so obtained the longitudinal strength we have gone a very considerable way to have the necessary strength in a radial direction as well. At Elswick we have now made and issued somewhere over forty guns upon this construction, with some of which we have obtained very remarkable results. These guns vary in size from 10-inch down to 6-inch, with a few smaller guns for field or howitzer purposes. I agree with Colonel Maitland's remarks about the weight of guns, but there are some purposes, as indeed he has indicated, where a light gun is exceedingly desirable. I may particularize, in addition to these he has cited, the case of its being desired to mount a gun upon a disappearing carriage, or any arrangement in which you wished to store up the energy of the recoil. The ribbon or wire used at Elswick is not of so high a tensional strength as that required at the Royal Gun Factory. Our reason for that is because we consider it necessary that the wire or ribbon we use should be capable of permanent extension. We have not in our experiments found that we are certain of obtaining this with ribbon of so high a tensile strength as 100 tons per square inch. Time will not permit me to dwell upon the interesting experiments to which Colonel Maitland alluded as to the pressures obtained with similar lengths of cartridges fired in chambers of small and large calibre. I think I should say, with equal frankness to Colonel Maitland, that had I been asked, before any experiments had been made, to predict the pressures that would result from such experiments, I should not have predicted these results. I need not say I have been for many years acquainted with the fact to which Colonel Maitland drew attention, but I have not found the explanation, at all events to my mind, as insoluble as Colonel Maitland, backed by my friend Sir Frederick Bramwell, has seemed to think. I cannot admit that the two experiments can be treated as being under the same conditions, but as the explanation would be a long one I will pass it over. I agree with Colonel Maitland in the remarks as to the lead which this country has taken in ballistics during the last fifteen years, but not entirely as regards the history of that lead. I could wish, however, that Colonel Maitland had not left it for me to claim for this country the great step that was made in the year 1877, one of the years which I think he has somewhat unjustly criticized as being a year of great slumber in this country. It was in that year that we at Elswick designed, following out the principles which had been to experienced eyes pretty firmly established by the experiments of the Explosives Committee and other researches, and early in 1878 we tried a 78-cwt.

70-pr. 6-in. gun, and an 8-in. 11-ton 180-pr., which gave respectively, with very moderate pressures in the chamber, velocities in the former case of 2,066 feet per second, and in the latter of 2,182 feet per second. I think, and in some cases it has been frankly acknowledged abroad, that when Continental nations generally were talking of something like 1,500 feet as the highest velocities, that enormous stride in advance was a step of very great importance, and that that advance is, with every improvement since made in powder and other respects, a precursor of the re-armament which, with Colonel Maitland, I think is absolutely essential. Those guns were both lent to the English Government, and were the subject of a good deal of correspondence and discussion, and I think the facts about them ought to be pretty well known. Before passing to the question of chambering, I should like to say one word about our modes of estimating the length of guns. Following the old establishment routine, we are accustomed to call guns of so many calibres long, but according to the view I take of the length of a gun, I think the term is a misleading one, and I would prefer to see the length of guns given in numbers of lengths of the cartridge, or in numbers of expansions of the powder burned in the bore. The absolute length of the gun, as Colonel Maitland correctly pointed out, is very much greater than the old gun; but their real length, taken with reference to the point which I contend is the important length, is very much shorter than with the old guns, the expansions varying from one-half to one-third of the number of expansions that were allowed in the old pattern guns. Coming again to chambers, I may say that the necessity for chambering was first felt when we had to deal with existing muzzle-loading guns, in which, owing to the shortness of the guns, it was not possible to have length of cartridge, and in which it was therefore absolutely necessary to provide space for the large charges we then wanted to use. The proportions of the chambers which Colonel Maitland has given were those which we followed in the 6-inch and 8-inch guns to which I have just referred; but as in these guns we used the barrel as part of the structure contributing a good deal of strength in the longitudinal direction, we afterwards thought it wise, seeing the great structural weakness that the large diameter of chamber involved, to lengthen very considerably the powder-chamber and to reduce its diameter. I have very little to add upon this point to what Mr. Rendel said when he spoke the other day upon the subject, but I may sum up by saying that if the powder we have permits us to employ a long chamber, we have with that long chamber a lighter and a stronger gun. But to be able to use that lighter and stronger gun it is an absolute necessity that our powder should be free from any of that wave-action which is so disastrous when you have it established to a considerable extent. Now I may state two cases. We made a 12-inch gun in which we had a long chamber. That gun may be called a comparative failure in this way, that we were never able to fire it with the charges of English powder for which it was intended, on account of the high wave-pressures set up. But chambers of similar proportions have been used with the most perfect success, and with perfect freedom from wave-action abroad. In the 100-ton gun the chamber is a little over five diameters long, and there never has been a shadow of wave-pressure either with the Fossano powder or with the cocoa powder which has been used so successfully with it. I may also add, as somewhat strengthening the view I take of it, that in France their chambers are, I should think, rather over five calibres long, and in Germany they are approximately the same. In the Krupp gun—the 40-cm. gun you have there—the chamber is practically the same as in our 100-ton gun. There is one point I should like to correct in the table Colonel Maitland has given there. He gives as the result obtained from the 17-inch gun in Italy an energy of 46,660 foot-tons, but the real energy obtained in that gun with a pressure of 15 tons in the powder-chamber is 51,900 foot-tons. In the same way I calculate, supposing the same powder to be used, the energy to be obtained from the 16¼-inch gun at 61,200 foot-tons, that is, using exactly the same data obtained with the shorter guns, instead of 50,920 foot-tons.

The CHAIRMAN: I greatly regret that I am obliged by other engagements to withdraw from the chair on this occasion. I have to thank the Members of the Institution for having permitted me to take part in a discussion the importance of which probably cannot be exceeded, both to the Service and to the country at large.

If I refrain from expressing any opinion upon the questions which have been raised, I may at least be permitted to say this, that it is the duty of all the Members of the Institution, and of all of us who have any interest in the security and prosperity of the country, to obtain for the two great Services the most efficient and most complete weapons which can be placed in their hands. I say so I believe in the interests of economy as well as in the interests of efficiency, and I trust one of the results of the exceedingly interesting and important paper which has been read, and of the discussion which has followed, will be to give more energy and more rapidity to the preparation of those weapons which, as I have said before, are essential to the security and the safety of the country.

Mr. W. H. Smith then left the Meeting, and the chair was taken by Admiral Boys.

Lieutenant-Colonel MAURICE, R.A.: I should like to ask Colonel Maitland a question with regard to what fell from Sir Frederick Bramwell. With the greatest diffidence I venture to say that I was unable to see the force of what Sir Frederick Bramwell said, and I should have felt much more diffidence about it two or three minutes ago. I sent up my card at the very commencement of Captain Noble's remarks, and it was a great relief to me to find that he too did not entirely concur with Sir Frederick Bramwell. Therefore, perhaps I may venture to say what puzzled me with regard to it. I think it would be advantageous if Colonel Maitland would clear up the matter for us. Everyone will remember the very striking part of Colonel Maitland's lecture in which, with reference to that Diagram (No. 22), he told us that a limit had practically been arrived at beyond which it was impossible usefully to employ powder in the gun. He frankly added that there was some puzzle connected with it and asked for an explanation. Colonel Hope offered an explanation which may have been right or wrong—I cannot say. But I must say when Sir Frederick Bramwell came to answer that explanation it did seem to me that the answer was entirely unsatisfactory. As I understand it, what Colonel Hope says in effect is this: that when you light the powder in the cartridge at a certain point in the rear, you immediately convert into gas at a high pressure a certain portion of the powder which immediately begins to act upon the remainder of the powder that has not been up to that time inflamed. So far he agrees both with our text-books and with everything that we have been taught about it. But here the difference begins. We have always been accustomed to hear that when there was a surplus of powder beyond what was immediately inflamed, what happened was that that surplus powder was liable to be blown out at the bore. "No," says Colonel Hope, "that is pure theory. If you want to know what happens to powder exploded under these conditions, you can only arrive at it by experiments with powder exposed to extreme pressure in a closed vessel, for that, no matter whether a projectile be large or small, will be the actual condition of the powder ignited in the second instance up to the time the projectile is moved." "Now," he says, "you will find that the powder so inflamed under intense pressure develops a sudden energy out of all proportion to the energy developed by powder not exposed to such pressure, and as a necessary consequence you will have gas at two or more different states of expansive energy acting and reacting within the chamber, and tending to produce not a steady force of direct propulsion, but a violent disruptive energy at a particular point, and to counter-act against one another." Now that may be true or may not; but Sir Frederick Bramwell did not say that that statement had been proved by any series of experiments to be mistaken, but he did say that it did not explain the action of those two cartridges as shown on the board. I cannot see that. It seems to me, supposing it to be true that you are dealing in the first place with a practically closed chamber, until the shot is moved, the difference in the size of the projectile becomes a very insignificant affair; and so far as the question of the increase of calibre is concerned, if it be true that in the case of a too long cartridge, the powder close up to the projectile itself is exposed to extreme pressure and then ignited, and therefore develops the violent disruptive energy which tends in the first place to burst the gun at that point, and in the second place to produce powders of different pressures, causing that very difficulty which Colonel Maitland has told us is most serious. Then the same thing, *mutatis mutandis*, will certainly happen to a cartridge of too large

calibre. The difference would simply be that the surplus powder round the cartridge would be driven up against the sides of the chamber, instead of against the base of the projectile. It would be equally exposed to extreme pressure, and inflamed under extreme pressure; and therefore you will get these varying pressures within the chamber which prevent you from getting the long-sustained regular pressure, and will give you varying pressures in the bore. Moreover, as I understand him, Colonel Hope, having so far explained the cause of your gaining no advantage either from the too thick cartridge or from the too long cartridge as being due to irregularity and uncertainty of ignition in different parts of the cartridge, goes on to say that he has actually experimentally shown that it is possible to get over that difficulty by lighting your long cartridge simultaneously at a great many points throughout its length, so as to obtain precisely a "low maximum pressure long sustained," and yet also getting a pressure proportionate to the greater length of the cartridge. Again I say that may be a mistake, but I do not think it will be satisfactory unless it can be proved to be a mistake by experiment. I think that after the way in which Colonel Maitland has shown us that the whole point of the possible development of future energy in the gun is stopped at that point of 3½ calibres, it will be a most unsatisfactory thing if, without specific experiment, it should be asserted that we can go no further. Therefore I should like to ask Colonel Maitland if he will tell us—1st. What experiments have been made upon powder exposed to high pressures within a closed vessel, and what have been the results. 2nd. Whether any experiments have been made in inflaming a cartridge much longer than 4 calibres, say up to 15, simultaneously at a great many different points throughout its length. It would be an unfortunate thing that Sir Frederick Bramwell's answer as it stands should go forth as the answer of the Ordnance Select Committee to what Colonel Hope said. The number of people who nowadays are able to follow every stage in the progress of guns, and every incident of those experiments, is exceedingly small; but the number of people who are convinced that there is no such thing as a Pope in matters of scientific investigation, and that where you refuse to accept results obtained by experiment, you can only meet them by producing results obtained by yet more exhaustive and conclusive experiments, is very large indeed. And, moreover, where there has been, as I cannot help thinking there has been in this instance, a distinct flaw in the answer given, the number of people who upon any authority whatever are ready to accept an answer made to an argument founded on experiment, where that answer contains a flaw, is nowadays very small. If I may be allowed to say so, every gunner is disposed very heartily to thank Colonel Maitland for the admirable account he has given us of the work done by his Department of late years. But when you are asking for money to be spent very largely upon the re-armament of the whole of our forces with a gun, the efficiency of which is expressly limited by the fact that it cannot usefully consume more powder than is represented by a cartridge of 3½ calibres in length, and when it is alleged that it is possible to obtain a development of powder which is to that as 15 to 3½, it seems to me it will add enormously to the effect of the appeal if it can be shown by direct experiment that Colonel Hope's results are not those which he alleges that by direct experiment he has found them to be.[1]

[1] In order to bring out more clearly the point of the second question, which I put to Colonel Maitland, and the deduction to be drawn from the answers made to me by Captain Noble, after Colonel Maitland had referred me to him, it must of course be understood that the question turns upon the results of experiments in which the cartridge has been *successfully* inflamed simultaneously at a very large number of points. Colonel Maitland has told us in his lecture of *attempts* to inflame a cartridge at four or five different points; and I suppose therefore that it may be understood that the "irregular and uncertain results" which, in his final answer, he said had been obtained in this matter, apply to these attempts. They do not evidently touch Colonel Hope's assertion that he has by his method successfully lighted a long cartridge at 140 different points simultaneously. Captain Noble's answer to my second question shows clearly how very important this result is, nor am I able to see that it is affected by Colonel Maitland's citation of a series

Mr. W. H. Barlow (Past President of the Institution of Civil Engineers): My only object in rising was to state what I understood Sir Frederick Bramwell to say. He spoke in reply to a remark of Colonel Hope's—Colonel Hope had been giving what he termed an explanation of wave-pressure. The only thing Sir Frederick Bramwell said was that his explanation was not sufficient—it was not an explanation of the fact that wave-pressure was dependent not upon length alone, but upon the ratio of the diameter to the length, and I cannot help thinking Sir Frederick Bramwell was right. I think also that that table of Colonel Maitland's, assuming the figures to be right, exemplifies more correctly than anything else can do the relative merits of guns. It gives the number of foot-tons of energy which can be produced by a ton of gun, and looking at that table one cannot but see the improvement in construction creeping up from the old French system through Krupp's and Elswick's until it terminates in the wire system, which gives a better result than any other. I think that points to the conclusion already expressed by Captain Noble, that the wire system is one which ought to receive attentive study. It seems to me obvious that the gun which gives the greatest energy and power of penetration, with the least weight of gun, is the best gun.

Admiral Selwyn: I wish to draw attention to what I think is a piece of injustice. In this United Service Institution we believe that all foreign naval Officers, and all foreign military Officers, are equally brethren in arms so long as we have not to fight against them, and I do say it is a shame that Captain Engström, of the Swedish Navy, has been left out of mention altogether ever since the Exhibition of 1861, in which he showed his system of breech-closure by a slotted screw, which was perfect for its time, and that it should not only not be called a Swedish system but be considered to be a French system. It is a most ingenious form of breech-loader, and that that should have been exhibited in 1861 is, I think, rather a reproach to the mechanics who did not know, or did not appreciate, how a sailor in the Swedish Navy could devise a better system of breech-loading than all that had gone before. I hope his name may be mentioned in connection with it, as it ought to be. Next I confess I sympathize entirely with Mr. Longridge in deprecating any statement by anyone that engineers and artillerists, or engineers and any other profession, treating mechanical questions, can possibly be at odds. An engineer is either a man who professes, with the least material, at the least expense, to produce the greatest effect, or else he is not an engineer at all, and to the extent that any man calling himself a mechanic or an artillerist, a soldier, or a sailor, departs from those sound principles on which engineering has based itself, he must go wrong. If we take it as an incident particularly attaching itself to guns, I mean to say the conclusion we must necessarily draw from Colonel Maitland's theory of natural selection is, that the longer and more clumsy the gun, the weaker and the less efficient the powder, the better ought to be the results. But that is not the conclusion anyone, least of all Colonel Maitland, can wish to come to, although it is a legitimate corollary of the proposition that he brings before us. I say, on the contrary, the whole question lies in the strength of the gun. If you can give us a strong gun, you can give us a strong powder, and we shall not be necessitated, in order to have good guns, to employ weak powder or guns so long, as in some cases to become highly objectionable. Take, for instance, the case of a Moncrieff pit; a very serious question would arise if you have the gun of excessive length. In ships, if you give us guns on the broadside, as will undoubtedly be the case by-and-bye, you completely bar us from having those guns projecting out of the ports for fear our enemies should make use of them in a close attempt at ramming, in order to lever out the ship's side. In short, in every way, the clumsiness and unhandiness of the gun is increased on the plea that without it you cannot burn bad powder. Now, if this wire-construction gun has

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of figures which, however they were obtained, are declared by Colonel Hope not to represent in any respect whatever the actual results of his experiments. The matter is so important and so easily determined by public and open experiment that there can surely be no satisfactory reason for attempting to settle it by figures obtained in some secret manner and declared to be absolutely fictitious by the one person who is able to say that he saw the experiments.—M.

not come forward in the past, it has been for the same reason that steel did not in the past come forward at once. People would stick to something that they were doing, and would not believe that anything else could be done, and when at last they were forced by the action of foreign nations into the construction of guns of the better material—steel—they found that they had been waiting until some other nation, not the Anglo-Saxon race, had adopted that which was due to the inventive brain of one of England's eminent sons, Sir Henry Bessemer, and had got ahead of us because our officials would not listen to the native inventor. I maintain that you are repeating the error at the present day. You are going in for wire construction and ignoring the inventor. You say, "We prefer to feel our way towards that which we could be informed of fully if we only condescended to try the thing on the lines laid down by the inventor." Is that a mode of action that can possibly be wisely used? You listen to all that the inventor has done during thirty years, you consistently and persistently decline his offers, and repudiate all his efforts, and then when at last you find you can no longer resist his invention, you turn round and do the thing behind his back. Colonel Maitland says "Greater weight must be given, if we desire to use stronger powder." In another part of the paper he says, "In consequence of the great strength of the wire gun the weight would be too little." Is there any difficulty in proportioning the weight to the requirements? If you have an excess of strength, is there any reason to suppose that you could not have a wise disposition of weight which would enable you at once to go into experiments of what strong powder will do? Is there any reason why we should burn 500 lbs. of weak powder when 250 lbs. of strong powder would do the same work; or burn powder, considered as fuel, to make carbonic oxide and heavy smoke, when we could burn it to carbonic acid and make light smoke? There is a certain amount of common sense in the whole transaction which seems to me to be violated, and a great deal could be done if, besides a little more common sense, there was only just the ordinary courtesy to an inventor who has spent half a lifetime on this subject. If the War Office would only say, "Very well, Mr. Longridge, we have obtained very good results from the trials we have made with your gun so far, though we have not followed you. Now we will take your advice, and construct a gun on your theory, and if that beats ours, we shall be willing to accept it." The expense is not great, the time needed is remarkably less than that required for any other gun construction. Indeed the expense seems likely to be very much less, so that there are really an enormous number of reasons for going forward rapidly and consistently with the examination of wire construction, and declining to admire the beautiful system of construction which promises to put together in a highly ingenious manner—in order to resist the weakest possible powder—the longest and the most unhandy gun that can possibly be used.

Colonel A. Moncrieff, C.B.: Colonel Maitland states in his paper that the limit of reduction in the weight of the new guns has been reached, because if they are made any lighter, the gun-carriages would not be heavy and strong enough. This establishes the fact that the manner in which the new guns are to be mounted to some extent influences the decisions of those who have to decide upon the type of our guns of the future, at any rate as far as their weight is concerned. That being so, perhaps my remarks on that part of the subject, to which Captain Noble has already referred, may not be out of place. The method of mounting guns with which my name is associated was commenced with counterweight disappearing carriages. Those counterweight carriages were contrived for the old and less powerful kind of gun, and they are better suited for that class of artillery, and not so well suited for the modern and more powerful guns which we have before us here. But, on the other hand, it is well to note that the hydropneumatic disappearing carriages, which I so strongly advocate, are much better suited for the new and more powerful guns, and not so well suited for the old ones. The reason that Moncrieff hydropneumatic carriages are better suited for guns more powerful in proportion to their weight is this: such carriages are able to absorb any amount of energy from the recoil, and also to utilize it by bringing the gun down into cover, to the loading position. The increase of energy of recoil on the lightness of the gun in proportion to its power is, therefore, instead of a difficulty, a positive

advantage in that new method of mounting. This being the case, I should like to ask Colonel Maitland whether he has considered, or whether it has been considered in connection with this most important and serious decision, viz., fixing the type—more especially in regard to its weight—of the gun of the future, that for various reasons it is highly probable that many of the new guns will eventually be mounted on hydropneumatic carriages, and if not, whether he would be so good as to make the suggestion to those who have to decide this important point. I might also further remark, while on this subject, that for sea service, and indeed for other purposes, the recoil of violent guns might be better controlled by resorting to hydropneumatic compressors, instead of using *hydraulic* compressors, because an elastic fluid is better suited than a non-elastic one for meeting violent strains, and moreover my hydropneumatic compressor saves the labour of running out the gun, whether on a level or inclined platform. This condition might be valuable and convenient in boat service.

Captain NOBLE: I may say that I do not entirely concur with the view that Sir Frederick Bramwell expressed. Of course, I speak with very great deference to his opinions; but I do think that Colonel Hope did make a point in referring to his cartridge, and that was, that he conceived the high pressure might occasionally be developed by the fluid products of the explosion surrounding powder still unexploded, which thus becomes burned in a greatly reduced space, or may be considered as powder of greatly increased density; that is to say, that having the interstices between the grains filled up by fluid will conduce to the attainment of very high pressures. The highest pressure which I have actually measured resulting from fired gunpowder in a closed vessel is somewhere about 78 tons to the square inch, and that was the result of a charge of about 28 lbs. of powder at a density of 1·2. It was fired in a cylinder strengthened by ribbon or wire. As to the second point, I may say that the mode of ignition at different points simultaneously has been tried frequently, and with different results. Sometimes it has been perfectly successful in avoiding those violent impulses of wave-actions and sometimes it has failed; and I fancy it was a knowledge of these failures which led Colonel Maitland to make the remark he did. There is no doubt, if you could be perfectly certain of igniting your cartridge simultaneously at a number of points, you would avoid these wave-pressures, and you would have practically the pressure due to the density of the charge, and to the time necessary for complete combustion.

Colonel MAITLAND: I am afraid I cannot reply at much length to the number of valuable speeches that have been made, but I will endeavour to run over the various questions as rapidly as possible. Admiral Boys asked what was the usual life of our present guns, and what has been done in the way of rapid firing. The term "life" is hardly applicable to our present guns, because I do not think that they die. We can put a lining inside, which will give them a new career, and I hope we shall make them as good as ever by putting in that lining. How long a lining will last, is at present rather a difficult question to answer. It is not a question of danger, it is one of accuracy; for if you fire a gun too long the rifling is injured, and the shot will not rotate so as to have the same accuracy as when the gun was new. It is not a question of danger of the gun bursting, but merely a question of hitting the enemy; and, no doubt, when the guns come home and the ship is paid off, they will have to be lined afresh so as to be issued in a shape of comparatively new birth to a ship going abroad. It will be desirable to send out every gun in as perfect a shape as possible by relining. A 6-inch gun has fired on the "Bulldog" some 800 rounds, and is perfectly good still. As regards "rapid firing," we have had no very extended trial yet of a large gun; the biggest is an 8-inch gun of 12 tons; that, when being tried at Shoeburyness, fired 160 or 170 rounds in two days, with 100 lbs. of powder and 210-lb. shell, the velocity being 2,030 foot-seconds. Sixty-seven rounds were fired in one morning between breakfast and lunch, the last five rounds being fired for rapidity in 4½ minutes. The gun was as good, except for the usual amount of wear and tear, at the end as at the beginning. I have listened with much interest to Mr. Rendel's thoughtful criticism about the chambering. I need hardly say I agree entirely with Mr. Rendel as to the principle. There is no doubt that chambering should be carried no further than is absolutely necessitated by the powder. I have been very keenly alive to that all along, and all our guns

designed within the past two or three years have been so designed that the chambers can be lengthened to take longer cartridges, and thereby still further increase their powers, should it be found that the powder will stand this. You will observe in the diagram showing the 63-ton gun, that the breech-piece is carried well forward, so as to permit of the enlargement of the bore to form a longer chamber. At present, our experience has not been quite as favourable as described by Captain Noble to-day. It is not very long ago that we were firing cocoa powder—that is the very latest development—in a 10·4 breech-loader, which is an experimental gun. In that gun the chamber is 4·46 times as long as its diameter. It was fired with 260, 240, and 220 lbs. of powder. Two independent gauges were placed in the base of each cartridge. The 260 lb. charge gave pressures of 22·5 tons and 22·2 tons, with a velocity of 2,213—an extremely good result. The charge was then reduced to 240 lbs., and the gauges gave 24 tons and 24 tons, the velocity being 2,149. The charge was further reduced to 220 lbs., the pressures then were 15·2 and 15·3, and the velocity 1,923, a 462-lb. shot being used in each case. Thus you have a higher pressure with a lower charge. You have a tremendous jump from 15·2 to 24, and you have a slight drop again with 260 lbs. to 22½. You see there you have a case where the velocity is tolerably regular, and the pressures jump about in a most capricious manner: that to my mind is a clear indication of wave-action. It is impossible to use 240 lbs. without risking a wave-action; and yet 260 lbs., in this particular case, only gave 22½ tons. There is every reason to suppose that, if we had fired another round or two with 260 lbs., we should have got a very high pressure. The moment we get powder that does not give wave-action, I shall be the first to make experiments with it and to lengthen the chambers. The subject has been very carefully watched. Colonel Hope tells us that he has a means of lighting his powder in 140 places, and getting the pressure perfectly uniform all over the chamber. It is a great thing to know that. May I ask Colonel Hope whether he did this in the trials in France, when the gun made for him by the Terre Noire Company was tried? Whether he used that expedient?

Colonel HOPE: Yes.

Colonel MAITLAND: I find that on that occasion, when firing 47½ lb. shot, the gun weighing 7¾ tons, and with a charge of 37½ lbs. of powder, Colonel Hope got 32·6 and 33·4 tons of pressure, the velocity being 2,306; with 37 lbs. of powder of the same kind, he got 2,340,[1] 34 feet more, and the pressure dropped from 33 to 23½. With 31 lbs. only of another powder he got pressures of 46·1 and 49·2 tons to the square inch, the velocity being 2,300 f.s. I do not think that is evidence of avoiding wave-action altogether. It seems to me he has a most tremendous wave-action in this cartridge, which he says is lighted in 140 places at once, and that is not, I think, an unmixed success.

Colonel HOPE: Those figures are not supplied by me, and they are not accurate.

Colonel MAITLAND: I got them from France, and have every reason to suppose them accurate. Mr. Longridge says he can make a gun which will have an energy of 1,000 tons per ton of gun. I wish he would do it. Even in a small gun I think I am right in saying he has not done it yet, and when he says that the engineering points are just the same in a steam-engine as they are in a gun, I think I answered that in my lecture, and I do not think you will find a single real gunmaker who looks upon it in the same way. As to rotation, I have not dealt with that subject at all. It is a very large one, and as long as you have given a certain spin to the shot, it does not matter how you give it. The only thing is to secure a method of giving rotation which wears as long as possible under the eroding action of the gas. I have very little to say in reply to Captain Noble. I should be very sorry to have to answer any of his criticisms. It would not be an easy thing to do. I should, however, like to say one word about the power required to close the breech with the two systems of obturation—the Elswick system and the De Bange system.

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[1] This, the highest result obtained, developed 231 tons energy per ton of gun. The Royal Gun Factory 6-inch gun of 4½ tons realizes 594 tons energy per ton of gun with Service pressure.—E. M.

With the 6-inch gun it is a little easier with the De Bange. Referring to the 43-ton gun, I do not quite know what pressure is put on in the hydraulic system of loading, and the pressure might have been very high, but there is no gauge to show it; at the same time, when a man works it with an iron lever, he manages to close the breech, even though the hydraulic cylinder does not do it. I am now speaking of the trials which took place on board the "Handy." Captain Noble remarked that he only knew about four guns that had required re-coppering. Well, we have had several; we began, as I told you, with the Elswick obturation, and there were a great many that required new coppering. There would have been an escape of gas which would very quickly have worn out the caps and rings when once it began to do so. We found that coppering was a troublesome operation; I do not say that it is worse than re-venting; the re-venting was a very troublesome thing in the old days, though now it is not so, because we have movable vents in all the guns. Then as to the advance of artillery science due to Elswick in 1878, with reference to the 6-inch and the 8-inch guns; no doubt these guns were considerable successes, but they were not in the Service in those times. I was of course speaking of the Service artillery of that time, and not of one or two experimental guns. With regard to the increase of power lately gained by the 100-ton Elswick gun above that shown on the table, I accept Captain Noble's statement at once, and I am sorry I did not know it before. I think Colonel Maurice has been answered by Captain Noble, and therefore I need not say much on that point. With regard to lighting the cartridge at different points, we have tried that very often. It has been tried with tubes pierced with holes, but the results, as Captain Noble says, have been extremely capricious; sometimes satisfactory, and sometimes giving dangerous pressures, such as are liable to burst a gun, and hence the method could not be adopted into the Service, because of course a burst gun is a very serious matter. Admiral Selwyn says that I ought to have mentioned Mr. Engström's name. Now the fact is that the system which we call the French, the interrupted screw, is adopted in some old American guns that are now lying in the Arsenal, which were supplied shortly after the Crimean war. It is just the same principle, so that I do not think that anyone in 1861 could lay claim to it at all. Colonel Moncrieff mentioned his carriages, and asked me to instigate the authorities to try them with the new guns. I am afraid I should have enough to do if I were to enter into matters of that kind, which are not in my own Department. I should be very glad to be enabled to make the guns lighter. Colonel Moncrieff, I know, is a very good hand at instigating the authorities himself, and he shall certainly have my good word, if it is worth anything. The most important criticism, of course, on the lecture is that of Mr. Rendel, about the chambers. It is purely a question of wave-action. If we can get powder which will not set up wave-action, all the chambers can be lengthened at once. It is a great matter to have our attention called to all these points, and wherever a suggestion seems practicable. I am sure we shall very gladly adopt it. I have to thank you very much for your kind attention.

The CHAIRMAN (Admiral Boys): It is now my pleasing duty to return your thanks to Colonel Maitland for his extremely interesting lecture, and also for the very interesting discussion which it has provoked. Very frequently in this theatre discussions are all on one side, but in this case we have certainly had a variety of views, and I hope that the information which has been given will turn out to be very useful in inducing the authorities to press forward in the right direction.

Friday, June 13, 1884.

VICE-ADMIRAL R. V. HAMILTON, C.B., Member of Council, in the Chair.

COLLISIONS OF SHIPS IN FOGS.

By Admiral Sir ALFRED P. RYDER, K.C.B.

THE subject of collisions of ships in fogs at sea, and how they may best be prevented or diminished in frequency, is very important, and has occupied the minds of many persons interested in the question.

It is probable that there was a rule of the road at sea in use among the galleys of the Greeks and Romans, but it has not reached us.

I will not occupy your time by tracing the history of our "Rule of the Road," or of the special clauses applicable to fogs. This branch—the antiquarian branch—having been well treated in a work by Captain Philip Colomb, R.N.[1]

I have placed on the walls the clauses of the Regulations (applying to Fogs) in force in England, and by mutual agreement in twenty-eight foreign countries. Although not so entitled officially, these Regulations may be not incorrectly spoken of as *International* Regulations.[2]

The title of this paper covers the question of collisions of ships when the vessels are at anchor, and that foul when drifting, also of two sailing vessels, also of a steamer and a sailing vessel. But my remarks will be confined to the case in which both vessels are *steamers* and *underweigh;* and more particularly to the important question of the "speed" of steamers in fogs, and the alteration in *speed* which should be made by one steamer on hearing a fog-signal from another steamer in the different directions *ahead*, on *either bow*, on *either beam*, *abaft either beam*, *astern*.

It will be competent, however, to the speakers to treat of the *alteration of course* which one steamer should make on hearing the fog-signal of another steamer, ahead, on either bow, on either beam, &c., whether towards the other vessel or away from her, or whether no alteration should be made, also on the moot point as to whether, when a fog-signal is heard by A ahead or on either bow or beam, it may be assumed that the vessel A is in "immediate danger" (see Art. 23), and that therefore A's Captain may obey the dictates of seamanship and ignore the Regulations, Arts. 16—22, which if the signal is heard on the port side directs him to "keep his course."

The International Regulation, Art. 13, is very short, and at first

[1] "The Law of Port Helm." Harrison and Sons, Pall Mall. Price 2*s.* 6*d.*

[2] There is as yet no International Law on the subject.

sight appears simple, but is rather loosely worded, as has been admitted by experts. It is as follows:—

"Every ship, whether a sailing ship or steamship, shall, in a fog, mist, or falling snow, go at a moderate speed." As read literally, it would seem to be obligatory on all vessels that when at anchor are involved in a fog to *get under weigh*, and as all vessels in a fog, &c., are to go at a "moderate" speed, none, in literal obedience to this regulation, ought to stop or go at less than a "moderate" speed. If any review of these regulations is authoritatively undertaken with a view to change, this clause will perhaps be amended so as to remove all ambiguity.

The Society of Arts undertook the inquiry with "the full concurrence of the Board of Trade, and with the cordial co-operation of the Marine Department," and appointed a Committee to inquire into this question.

The Fog Collision Committee, appointed by the Council of the Society of Arts, consisted of:—Sir W. Siemens, Sir F. Abel, *ex officio* as Chairmen of the Council; Admiral A. P. Ryder, Chairman; Lord Alfred Churchill, Sir F. Bramwell, Admiral Sir E. A. Inglefield, B. F. Cobb, Esq., A. Cassells, Esq., Loftus Perkins, Esq.

At the first meeting of the Fog Collision Committee, Sir W. Siemens, Chairman of the Council of the Society of Arts, took the chair. At the second meeting, owing to his death, I was requested to become Chairman of the Committee, and continued so until the preliminary Report was finally adopted. The Committee sat frequently, and the preliminary Report, which I drew up, was amended by and in its present shape finally adopted by the Committee *nem. con.*, and presented to the Council, who ordered it to be printed and submitted to the Admiralty, the Board of Trade, the Trinity House, &c., which has been done.

The prestige of the Society of Arts, and the encouragement given to its action in this matter by the Board of Trade—and especially by the Marine Branch, enabled the Committee to elicit a great deal of valuable information from directors of fifteen steam companies—Captains of steamers in those companies, naval Officers, and others.

It occurred to me after we had received the very important evidence of some of the Captains in first-class lines of steamers to the effect "that they always went at full speed in fogs in the open ocean; that they knew it was in direct disobedience to the law; that the law was absurd, and that they always intended to break it"—that I might be able to prepare a useful paper for this Institution which, disseminated widely through the Royal Navy, would, if it served no other purpose, warn my brother Officers in command what to expect, and put them on their guard, viz., that English merchant steamers—especially in the principal lines of packets now crossing the ocean in large numbers—may be expected to be in this respect always breaking the law. It may be news to my law-abiding[1] brother Officers,

[1] The speed of English men-of-war in fleets in fogs is limited by the Admiralty Regulations to from 3 to 4 knots, unless under special circumstances, and single ships are ordered not to exceed "moderate" speed, unless, &c.

Admirals and senior Officers, who when in command of fleets in the open ocean always drop the speed of the ships under their orders to from 3 to 4 knots, and when in single ships always moderate their speed, unless the urgency of their sailing orders justifies in their opinion a higher speed than "moderate," that this international regulation, to which they yield so ready an obedience, is so continually and pertinaciously broken by their brethren of the merchant service, in spite of the injunctions they may receive from their directors "to comply with the law."

When discussing the most important questions which arise under these Regulations, viz., those where room is left for a difference of opinion as to which of one of two or more courses should be adopted by each vessel, both courses being left optional by the law, it must at first be assumed—to narrow the argument to debatable ground—that both vessels when making their fog-signals are complying with the law and going at not more than "moderate" speed.

But the almost universal practice confessed to by the masters of ships in some of the most important "lines" traverses the above conclusion, and leaves my law-abiding brother Officers in this embarrassment, viz., that if the fog-signal they hear proceeds from an English man-of-war they may be reasonably certain that the speed is not in excess of moderate—say 3 to 4 knots; whereas if it proceeds from an English merchant steamer (in the open ocean), she is probably going at full speed—say 13 to 15 knots.

As the Captain cannot discriminate between the fog-signal of a man-of-war and that of a merchant ship, he is tempted to the conclusion that he must endeavour to estimate the amount of probability as to whether the sound comes from a merchant steamer or a man-of-war. As the former are the more numerous in the most frequented portions of the ocean, that question is soon decided—and it may evidently be most *prudent* on his (the Captain of the English man-of-war's) part—as regards the chance of collision, to act as though the other ship were breaking the law and going at full speed; and yet if a collision did nevertheless take place, the Court would not absolve him from blame: the Court would hold that he ought to have assumed, *having no direct evidence* to the contrary as regarded that individual merchant steamer or her Captain, that she was obeying the law and going at *moderate* speed.

While the law and the almost universal practice of the merchant steamers on the principal lines when in the open ocean in fogs remain at direct issue, the whole question is in inextricable confusion. Certain resolutions[1] touching on the laws applicable to collisions at sea were

[1] Resolutions relating to collisions at sea proposed by H. W. Freeland, Esq., at a meeting of the Association for the Reform and Codification of the Law of Nations, held at Milan in September, 1883, and adopted:—

1. "That it is a duty incumbent on all the maritime Powers to adopt a uniform code of laws applicable to cases of collisions at sea, with special reference to the questions of jurisdiction.

2. "That simplicity and harmony in the regulations relating to collisions at sea are the best guarantee for the security of life and property.

3. "That it is desirable that the maritime Powers should agree to establish a Court

proposed and carried by H. W. Freeland, Esq., at Milan last year, at a meeting of the Association for the Reform and Codification of the Law of Nations, which, if adopted, will afford an opportunity for reconsidering some important questions.

I will now proceed to give you the conclusions arrived at by the Fog Collision Committee of the Society of Arts, and state how they arrived at them.

Some points of interest arose in the course of our inquiry to which we alluded in the Appendix to the Report. I will touch lightly on them at the end of this paper under the heading *Miscellaneous*.

Preliminary Report of a Special Committee of the Society of Arts on Collisions of Steamers in Fogs.

The following Report was drawn up by Admiral A. P. Ryder, Chairman of the Committee of the Society of Arts on Collisions in Fogs, for the consideration of that Committee. The Report was adopted as amended in its present shape by the Committee, on the 16th of April, and circulated in the Journal of the Society by order of the Council on the 21st of April, 1884:—

To the Council of the Society of Arts.

1. This Committee was appointed by the Council on March 12th, 1883, to consider the question of collisions at sea. On further consideration it was determined that the work of the Committee should be confined to the question of collisions in *fogs*. The first action of the Committee was to insert a notice in the Society's Journal, inviting communications and suggestions from persons interested in the subject. In response to this notice they have received sixty-nine

of International Appeal whose decisions might be called for by such Powers respectively in case of disagreement between them as regards the interpretation and application of the International Laws and Regulations relating to Collisions at Sea.

4. "That, in order to obviate all risks of incorrect translation, it is desirable that the maritime Powers should nominate an International Commission composed of experts carefully chosen charged with the preparation and publication of a polyglot text of the Laws and Regulations relating to Collisions at Sea."

The necessity of some such steps is pointedly illustrated by the well known collision case of the "City of Mecca" (British merchant steamer), and the "Insulano" (a Portuguese merchant steamer), off Lisbon, in 1875, in which it was proved that the Portuguese translation of the English rules was so much in error as to cause grave international complications. (See the following Parliamentary Blue Books: 1882, C.—3443, 3*s*. 6*d*.; 1883, C.—3555, 2½*d*.; 1884, C.—3882, 1*d*.; and especially Sir Robert Morier's analysis of the evidence in this case, at pp. 104–120 of the first of the above-named Blue Books, and pp. 10–13 of the second, in which he raises most important questions regarding Rules 18 and 20 of the New Rules, viz.:—

18. "Every steamship, when approaching another ship, so as to involve risk of collision, shall slacken her speed or stop and reverse if necessary.

20. "Notwithstanding anything contained in any preceding Article, every ship, whether a sailing ship or a steamship, *overtaking* any other, shall keep out of the way of the overtaken ship."

Both of which Rules Sir Robert Morier considers to be objectionable and mischievous.

communications. A summary of all these will be given as an appendix to the final Report. The Committee feel much indebted to the many gentlemen who have submitted these suggestions, but they do not consider themselves in a position to recommend any one of the systems described in preference to the others.

2. Nearly all the methods proposed assume the desirability of a code, international or not, of fog signals, and in many of the inventions great ingenuity has been displayed. Supposing the objections to an elaborate code to be got over, there can be little doubt that several of the systems proposed would be very well adapted for the purposes required. The Committee, however, after giving special attention to the question of an international code of fog-signals, have come to the conclusion that the introduction of an international code for use by merchant ships would be more likely to cause confusion or disaster than to conduce to safety, first, because the difficulty of making intelligible signals in a fog is very great; and secondly, because it is to be feared that the authorization of such a code would foster a fancied feeling of security, and encourage the practice of steaming at high speed under dangerous circumstances. The Committee believe that the utmost that could be done would be an indication of the direction of the ship's head as regards the vessel she is signalling to, as proposed by Mr. Rothery; and, in crowded channels, the indication by steamers of the fact that they were outward or homeward bound. At the same time the Committee are fully sensible of the desirability of increasing by all possible means the power of fog-horns, and the general adoption of some form of "siren" (an improved steam whistle) for use on board ship.

3. The Committee on Collisions in Fogs has confined its attention in this preliminary Report to collisions of *steamers* in fogs. The Committee has examined orally, and by aid of printed questions widely distributed, a considerable number of witnesses, including shipowners, Officers of the Royal Navy, and of the merchant service.

4. It has been the Committee's aim, among other important questions, to ascertain what is the general practice in *steamers*, including both men-of-war and merchant ships, as to the *very* important question of the *speeds* maintained by steamers during fogs, both in the *open ocean* and in *narrow waters*.

5. The law laid down in the International Regulations for Preventing Collisions at Sea[1] is that "Every ship shall in a fog go at a 'moderate speed.'"[2] The Committee has no doubt, judging by the evidence, that the illegal practice, pursued by many steamers, of proceeding in

[1] The Regulations for Preventing Collisions at Sea have been prepared by the English Government, and submitted to all foreign mercantile nations, and adopted by twenty-eight of them, and thus made *international*. These nations are:—Austria-Hungary, Belgium, Brazil, Chili, Cochin, Denmark, Ecuador, France, Germany, Great Britain, Greece, Hawaii, Italy, Japan, Kattywar, Khelat, Kutch, Netherlands, Muscat, Norway, Portugal, Russia, Spain, Sweden, Travancore, Turkey, United States, Zanzibar. These regulations can be obtained of J. D. Potter, 31, Poultry; and of E. Stanford, 55, Charing-cross, for twopence.

[2] Art. 13 states that "every ship, whether a sailing ship or steamship, shall, in fog, mist, or falling snow, go at a moderate speed."

proposed and carried by H. W. Freeland, Esq., at Milan last year, at a meeting of the Association for the Reform and Codification of the Law of Nations, which, if adopted, will afford an opportunity for reconsidering some important questions.

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PRELIMINARY REPORT OF A SPECIAL COMMITTEE OF THE SOCIETY OF ARTS ON COLLISIONS OF STEAMERS IN FOGS.

The following Report was drawn up by Admiral A. P. Ryder, Chairman of the Committee of the Society of Arts on Collisions in Fogs, for the consideration of that Committee. The Report was adopted as amended in its present shape by the Committee, on the 16th of April, and circulated in the Journal of the Society by order of the Council on the 21st of April, 1884:—

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of International Appeal whose decisions might be called for by such Powers respectively in case of disagreement between them as regards the interpretation and application of the International Laws and Regulations relating to Collisions at Sea.

4. "That, in order to obviate all risks of incorrect translation, it is desirable that the maritime Powers should nominate an International Commission composed of experts carefully chosen charged with the preparation and publication of a polyglot text of the Laws and Regulations relating to Collisions at Sea."

The necessity of some such steps is pointedly illustrated by the well known collision case of the "City of Mecca" (British merchant steamer), and the "Insulano" (a Portuguese merchant steamer), off Lisbon, in 1875, in which it was proved that the Portuguese translation of the English rules was so much in error as to cause grave international complications. (See the following Parliamentary Blue Books: 1882, C.—3443, 3*s.* 6*d.*; 1883, C.—3555, 2½*d.*; 1884, C.—3882, 1*d.*; and especially Sir Robert Morier's analysis of the evidence in this case, at pp. 104–120 of the first of the above-named Blue Books, and pp. 10–13 of the second, in which he raises most important questions regarding Rules 18 and 20 of the New Rules, viz.:—

18. "Every steamship, when approaching another ship, so as to involve risk of collision, shall slacken her speed or stop and reverse if necessary.

20. "Notwithstanding anything contained in any preceding Article, every ship, whether a sailing ship or a steamship, *overtaking* any other, shall keep out of the way of the overtaken ship."

Both of which Rules Sir Robert Morier considers to be objectionable and mischievous.

communications. A summary of all these will be given as an appendix to the final Report. The Committee feel much indebted to the many gentlemen who have submitted these suggestions, but they do not consider themselves in a position to recommend any one of the systems described in preference to the others.

2. Nearly all the methods proposed assume the desirability of a code, international or not, of fog signals, and in many of the inventions great ingenuity has been displayed. Supposing the objections to an elaborate code to be got over, there can be little doubt that several of the systems proposed would be very well adapted for the purposes required. The Committee, however, after giving special attention to the question of an international code of fog-signals, have come to the conclusion that the introduction of an international code for use by merchant ships would be more likely to cause confusion or disaster than to conduce to safety, first, because the difficulty of making intelligible signals in a fog is very great; and secondly, because it is to be feared that the authorization of such a code would foster a fancied feeling of security, and encourage the practice of steaming at high speed under dangerous circumstances. The Committee believe that the utmost that could be done would be an indication of the direction of the ship's head as regards the vessel she is signalling to, as proposed by Mr. Rothery; and, in crowded channels, the indication by steamers of the fact that they were outward or homeward bound. At the same time the Committee are fully sensible of the desirability of increasing by all possible means the power of fog-horns, and the general adoption of some form of "siren" (an improved steam whistle) for use on board ship.

3. The Committee on Collisions in Fogs has confined its attention in this preliminary Report to collisions of *steamers* in fogs. The Committee has examined orally, and by aid of printed questions widely distributed, a considerable number of witnesses, including shipowners, Officers of the Royal Navy, and of the merchant service.

4. It has been the Committee's aim, among other important questions, to ascertain what is the general practice in *steamers*, including both men-of-war and merchant ships, as to the *very* important question of the *speeds* maintained by steamers during fogs, both in the *open ocean* and in *narrow waters*.

5. The law laid down in the International Regulations for Preventing Collisions at Sea[1] is that "Every ship shall in a fog go at a 'moderate speed.'"[2] The Committee has no doubt, judging by the evidence, that the illegal practice, pursued by many steamers, of proceeding in

[1] The Regulations for Preventing Collisions at Sea have been prepared by the English Government, and submitted to all foreign mercantile nations, and adopted by twenty-eight of them, and thus made *international*. These nations are:—Austria-Hungary, Belgium, Brazil, Chili, Cochin, Denmark, Ecuador, France, Germany, Great Britain, Greece, Hawaii, Italy, Japan, Kattywar, Khelat, Kutch, Netherlands, Muscat, Norway, Portugal, Russia, Spain, Sweden, Travancore, Turkey, United States, Zanzibar. These regulations can be obtained of J. D. Potter, 31, Poultry; and of E. Stanford, 55, Charing-cross, for twopence.

[2] Art. 13 states that "every ship, whether a sailing ship or steamship, shall, in fog, mist, or falling snow, go at a moderate speed."

fogs at speeds other than "moderate," is not only very common in the merchant service, both in the "open ocean" and in "narrow waters," but is the almost invariable practice in the "open ocean" by many of the most important lines of steamers.

6. The Committee has no reason to doubt that the "law" is fairly well observed in vessels of war. The Naval Regulations prescribe 3 to 4 *knots* as the speed of vessels in a fog in a fleet, and this appears to be rarely exceeded in fleets. In single ships-of-war the assumed urgency of the sailing orders would probably in some cases lead to the speed being in excess of a "moderate" speed, but the International Regulations are as binding on Captains of men-of-war as on the Captains of merchant ships, and damages have been recovered in the same way from Captains of men-of-war as from the Captains or owners of merchant ships.

7. In a great deal of the evidence the Committee has obtained from Captains of merchant vessels, the witnesses have not hesitated to state plainly to the following effect, viz., that the practice of proceeding in fogs at speeds other than "moderate" is very common, if not universal, in the *open ocean*, in the principal lines of steamers. This evidence has been given to the Committee on the understanding that the names of the witnesses should not be disclosed.

8. The readers of this Report must, therefore, take the above statement on trust, as also that evidence has been invited and obtained from Officers of the principal lines of steam packets, with consent of the directors or owners.

9. The question that the Committee had to determine, so soon as it arrived at the conclusion that many of its witnesses were confessedly engaged in deliberately and frequently breaking the law, is not a little embarrassing. It appeared to the Committee that the question submitted to them had now assumed a very grave aspect, and that it might be well to record all the circumstances of the case in a *preliminary* Report, and place it before the Council of the Society of Arts, for their decision as to the further pursuit of the inquiry by this Committee; or whether, after careful consideration, it might not be better that such an important inquiry be transferred to some official body clothed with wider powers, and enabled to examine witnesses on oath.

10. If loss of life were caused by a collision of ships in a fog, and was followed by a civil action, and it was proved that one or other of the Captains was driving his vessel at a speed other than "moderate," it would be open to the jury to bring in a verdict of manslaughter against the Captain. The Courts that take cognizance of collisions are given below.[1]

[1] The proceedings in collision cases are as follows:—

1. A quasi-*Criminal* proceeding in the Wreck Commission Court, in which the question to be decided is whether the master or officers of one or both ships were to blame, and whether it would be proper, under the circumstances, to suspend or cancel their "certificates."

2. A purely *Civil* proceeding in the Admiralty Division of the High Court, before the Judge and two Assessors, as to which vessel was in fault, and by which of them

11. The Committee has no reason to doubt, after receiving the evidence alluded to above, that numerous vessels belonging to some of the most important steam-ship companies—ships of great value, crowded with passengers—are daily and hourly being driven through fogs in the open ocean by Captains who are knowingly breaking the law, and in danger of the above punishment. Now if the "law" is a wise one, or, in other words, if "moderate" speed in a fog be the safest to all concerned, and if speed other than moderate be dangerous, these Captains are wrongly imperilling the lives of their passengers and crews, and should be restrained in so doing.

12. It is evident that even the fear of the penalties incurred for manslaughter, when added to other punishments, such as forfeiture of "certificate," loss of position, &c., has no sufficient deterrent effect in this case. Whether the Captains referred to share the opinion of the law-makers, that there is more danger of collision, and from collision, when going *fast*—or rather at speed other than "moderate"—in a fog than there is when going at "moderate" speed; or, on the other hand, entertain the opinion that there is more safety in going at a higher speed than "moderate," their practice appears to be the same.

13. But even in the former case, viz., in that of Captains whose opinion (as seamen) is in favour, as a matter of prudence—of prudence apart from law—of limiting their speed to "moderate" in a fog, other considerations step in—the *requirements of the Post-office*, the *passengers' anxiety for a quick passage*, the *desire of the owners of the cargo for quick transit*, or the *owners' wishes;* and full speed in fogs in the open ocean is the rule, moderate speed the exception.

14. For whatever reason, the practice appears to be almost universal to break the law, and maintain full speed in fogs in the *open ocean.* Is this satisfactory? The Committee is unanimous in opinion that it is not satisfactory.

15. Three courses appear to be open to the Legislature, if the evidence this Committee has received is confirmed on oath.

(*a.*) To preserve the "*status quo.*"

(*b.*) To make the punishment for infringement of the law more stringent and deterrent, and define more clearly the word

the damage should be paid. There is an appeal to the Lords Justices and thence to the House of Lords.

3. A purely *Civil* proceeding before any of the Judges of the High Court, and a jury, to decide precisely the same question. There is an appeal to the Lords Justices and thence to the House of Lords.

4. A *Criminal* proceeding before a Judge and jury, to determine whether the master or officers, whose conduct is impugned, shall be punished criminally.

5. The case may also be decided by a Vice-Admiralty Court; in which case the appeal is to the Queen in Council, and is heard by the Judicial Committee of the Privy Council.

In the *first* of these cases, there is an appeal to a Divisional Court, thence to the Court of Appeal, the Lords Justices. In the *second* and *third* there is an appeal to the Court of Appeal (with sometimes an intermediate hearing before the Divisional Court), and finally, all three to the House of Lords. In the *fourth* case, the criminal trial, there is an appeal, only in certain cases, to the Court of Criminal Appeal. The findings in all the Courts may differ.

"moderate;" as, for instance, say, not exceeding 6 *knots*, or the lowest speed at which steerage-way can be maintained, if in any case that speed be more than 6 knots.

(*c.*) To alter the law, and free the Captains from the existing obligation to lower the speed to "*moderate*" in *fogs* on the *open ocean;* leaving the existing law applicable to ships in "*narrow waters.*" N.B.—The latter expression is defined further on.

16. The Committee need hardly say that there are difficulties surrounding each of these courses—it is, and must be, a choice of evils—and in the Committee's opinion it will be well that this, their *preliminary* Report, should be submitted to the Admiralty, to the Board of Trade, and be made public. So that, after the question has been well ventilated, it may be re-approached either by this Committee or by some other body.

17. The Committee do not hesitate to say, however, that they are unanimously of opinion that to adopt the *first* course, the "*status quo*," would be most objectionable; and that without giving any positive opinion at present, they are more in favour of the *third* course than of the *second*, and see no fatal objection to certain large open portions of the ocean being defined in the new Regulations, say all positions outside 50 miles distance from land, as by implication exempt from the obligation on steamers in such positions to go at moderate speed in fogs. N.B.—The distance, whether 50 miles or more, is a detail, but requires careful consideration. Any land such as the Madeira, Azores, &c., would be protected by a 50-mile limit, within which the privileges of "open ocean" should not extend.

18. There are objections of course to such a modification of the existing law; but the proposal, in the opinion of the Committee, without binding themselves to its approval, is well deserving of consideration by shipowners, seamen, &c. Large tracts of the ocean would be, so to say, privileged in fogs as "open ocean," and in much smaller tracts, under the designation of "narrow waters," ships would be protected from vessels at "immoderate" speeds. Its effect on the navigation of steam vessels would probably be this, that Captains on passing in fogs from "open ocean" to "narrow waters," or in other words, when within 50 miles from land, would either comply with the law, and proceed at "moderate" speed, or would redouble their precautions and multiply their "look-outs;" for if they did not comply with the law, and there and then "moderate" their speed, and a collision with loss of life ensued, the jury (in view of the alteration of the law into a closer conformity with almost universal usage) would probably not hesitate to award the full penalty attached to manslaughter.

19. At present the practice of running at full speed in fogs in the open ocean is so nearly universal, and so ably defended and ingeniously justified, that it is very possible no jury would convict.

20. Were the above suggestion adopted, the offences now constantly practised against the law imposing "moderate" speed in fogs would be confined to vessels *not on the open ocean*, would there-

fore be infinitely diminished in frequency, and more controllable. The new law would probably be regarded by shipowners, Captains, owners of goods, passengers, the Post-office, as *reasonable*, or at all events more reasonable than the present law, and obedience would be more readily given. Vessels that had crossed the Atlantic at full speed in a fog, under sanction of the amended law, would be more likely to "moderate" the speed in "narrow waters" than would be the case under the present law.

21. Vessels would still occasionally be run in "narrow waters" at higher speeds than "moderate:" collisions would still occur, and some loss of life, but the whole question would have advanced a stage, and the minds of the public would be prepared for further changes if found necessary. At present, and this is a very important consideration, the infraction of the law as to "moderate" speed in fogs is *never* taken cognizance of *except in cases of collision*, but if the proposed changes were made, the evidence of the logbooks might procure conviction at the end of the voyage, which, if followed by a fine levied on the Captain, even if paid by the owners, would have a deterrent effect, especially if the fine were increased at each conviction.

22. The Committee have had the advantage of receiving the evidence of shipowners of wide experience, who look upon the question from a different point of view from the Committee, as also from that of their own Captains, &c., and the opinions on this matter of the former class, viz., shipowners, require careful attention.

23. The managing director of a very important line of steamers produced the printed orders issued by the directors to their Captains. In *one* set of regulations, said to specially apply to the management of the ship in fogs in "narrow waters," the official International Regulations were emphasized with great stringency; no language could be stronger than the orders of the directors that reduction to "*moderate*" speed, down to "*stopping*," should be always practised in fogs. In another set of orders, from the same directors, applicable to the *open ocean*, the directions were confined to a few words, saying, "the Captains were in fogs to '*comply with the law.*'"

24. The directors of these Companies are well aware that their Captains break the law constantly; in fact that they navigate their vessels on almost every voyage, and sometimes throughout whole voyages, with, metaphorically speaking, ropes round their necks, and at first sight it might be supposed that the directors of a company whose ships were so conducted in defiance of the law would welcome the prospect of a change in the law; or would, at all events, when in the *open ocean*, wish to see their Captains relieved of this inconvenient appendage; but, surprising to state, it is not so, these directors wish for the *status quo*, and the reason may probably be as follows, and although it is not likely that they would assert it, they might admit it if pressed.

25. The general purport of the evidence from shipowners, directors, and Captains of merchant steamers in the most important "lines," may be summarized as follows:—"Our 'Company' is able to build *first-class* vessels of *great speed* and *handiness*, and *perfect* in all

their fittings, *lights*, *sirens*, &c., and able to pay such salaries as to secure the *best Captains* and *numerous* and *efficient crews*. The present law is wrong, is absurd, is unseamanlike, and more calculated to produce collisions than to prevent them; nevertheless, let the law remain as it is." But why? this Committee asks. The following is the outspoken answer of some of the Captains, the implied answer of others:—"There ought (but we know it is impossible) to be two laws, one for vessels like ours, *of great speed, perfectly handy, thoroughly well found, commanded by men like us of great nerve and vast experience, with subordinate officers like ours, all with masters' certificates*, &c. Such vessels should not be interfered with or embarrassed by any law against full speed under any circumstances; but slower, less handy, less well found vessels, commanded by comparatively inexperienced nervous men, become a nuisance if they attempt to go at full speeds in fogs—and, therefore, in theory, there should be a *second* law, constraining such vessels not merely to go at '*moderate*' speed, but to '*stop*' in a fog, and *keep on signalling their position;* they are dangerous to themselves and to us if they attempt to move in a fog, and some of them are aware of the fact, and do stop.[1] Finally, *we must break the law*, or we shall lose our positions, and our Company will lose its *freight*, *passengers*, and *mails*. On the whole, therefore, recognizing the impossibility of there being two laws, one for well found, handy vessels of great speed, and one for other vessels, we prefer the *status quo*, and will take our chance of collisions, and convictions of manslaughter, loss of certificates, &c."

26. This view of the matter the Committee believes, judging by the evidence, to largely prevail among the directors and Captains in first-class lines of steamers. The evidence given by many persons in this inquiry is liable (very often quite unconsciously to the witnesses themselves) to be twisted by oblique motives, whether personal or caused by *esprit de service*, and this must be carefully borne in mind on any future inquiry.

Three Classes of Reasons for disobeying the Law and proceeding at Full Speed in Fogs advanced by many of the Witnesses.

I. As Seamen.

(*a.*) Because the fog is thus most quickly traversed, and therefore the interval of time in which risk or danger is incurred is diminished by perhaps one-half or two-thirds, viz., by going, say, 16 to 12 knots instead of perhaps 4, the latter being probably the minimum speed at which the ship is manageable by the helm.

N.B.—4 knots is the fleet fog speed in the Royal Navy, and is generally accepted in the Royal Navy in single ships as a compli-

[1] A blindfolded man, walking about in a room, would much prefer that all other blindfolded persons should stop and indicate their positions instead of continuing to walk about. A person obliged to move quickly in a dark room would rightly consider his chances of collision with the furniture increased if the articles were also moving instead of at rest.

ance with the regulation to proceed at "moderate" speed in a fog.

(*b.*) Because the direction of the vessel's head can be more instantaneously altered by the action of the helm (also in a double-screw by reversing one screw) when at a high speed, than can be effected when at a moderate or at a slow speed.

(*c.*) Because the strong head of steam necessarily kept when at full speed enables an effective back-turn to be sooner given, and the vessel brought to a standstill, and, if necessary, driven more promptly astern, than when at moderate or at slow speed.

N.B.—The Committee are of opinion that this is an error.

(*d.*) Because the blow given to another ship, B, by A going at, say, 12 knots, or received by the ship A from the ship B going at 12 knots, is not likely to be more destructive to either ship than if the speeds were, say, 4 knots; both speeds 12 and 4 being almost equally likely to be fatal.

(*e.*) Because when going at "moderate" speed in a fog, but with the steam well up, in order to give a prompt and effective back-turn, the steam will often, in some ships, be "blowing off," and this will effectually prevent the fog-signals of any other ship from being heard.

(*f.*) It being understood, however, that this practice of driving at full speed in a fog, as above advocated, is invariably supplemented by the practice of "stopping" on hearing a fog-signal ahead or between ahead and three points on either bow, and of reducing the speed to the slowest speed at which the ship is manageable by the helm on hearing the fog-signal from any vessel apparently between the beam and three points on the bow.

II. As the Servants of the Owners of the Ships.

(*g.*) As the course most in accordance with the wishes of the owners.

Note.—No Captain would probably retain his command who acted otherwise, although his actions were strictly in accordance with the law, and with, very probably, urgent printed orders from the owner to invariably comply with the strict letter of the law.

III. As the Guardians of the Mails; of the Interests of the Passengers, and of the Interests of the owners of the Goods, Bound to Accelerate the Delivery of the Mails, the Passengers, and the Goods.

(*h.*) As the course most in accordance with the wishes of the Post-office, of the passengers, as also of the owners of the goods (probably fully insured). Passages are not infrequently made, not merely in narrow waters of the English and Irish Channels, but even across the Atlantic in a continuous fog throughout the voyage. Any line of packets or single ships that reduced their normal high speed

to "moderate" speed in the open ocean in fogs, except on hearing a fog-signal, would probably get neither cargo, nor passengers, nor mails.

A Circular Letter to the Masters of Merchant Steamers of the Principal Lines of Steam Packets.

Several copies of the following letter were sent by the Fog Collision Committee of the Society of Arts to the Directors of all the principal Steam Packet Companies in England, with a request that they should be given to their most experienced "masters," accompanied by an undertaking that the names of the "masters" who replied should not be printed. Numerous answers were received, and have been summarized.

SIR,

A Committee of the Society of Arts has been appointed to consider the question of collisions at sea in fogs. The inquiry was undertaken with the full concurrence of the Board of Trade, and with the cordial co-operation of the Marine Department.

I. SPEED IN FOGS.

1. The Committee have received some valuable evidence from experienced Officers of the Royal Navy and of the Merchant Service, which leads to the conclusion (if not contradicted by further evidence) that it is an almost universal practice for steamers in the Merchant Service, whether carrying mails or only passengers and goods, in the open ocean, to go at their normal or full speed in a thick fog, unless and until a fog-signal be heard ahead or on either bow; notwithstanding the International Regulations, Art. 13, which states that "Every ship, whether a sailing ship or a steamship, shall, in fog, mist, or falling snow, go at a moderate speed."

2. The above witnesses have justified this practice as, in their opinion, the most seamanlike course to pursue, whether in yachts (where there are no owners specially interested in quick passages, no mails, passengers, or goods) or in any other class of vessel; and this for various reasons, stated at length, and also as the only course that would be tolerated in merchant steamers by the *owners*, the *Post-office*, the *passengers*, and the *owners of goods*.

3. It is a matter of notoriety that the Judges in all the Courts condemn steamers after a collision as in default, if it be proved that they were going at full speed in a thick fog, whether in the open ocean or in narrow waters, instead of at a moderate speed; and that, although Judges have differed as to what was "moderate" speed in a fog, when no fog-signal was heard, yet that a speed as low as 6 knots has been held to be excessive, and the decision was not appealed against; also that 3 to 4 knots is ordered to be the maximum speed of English fleets in a fog, whether in the open ocean or in narrow or frequented waters. Under these circumstances, the Committee will be much obliged to you if you will state—

(*Q.* 1.) Does your experience guide you to the same conclusion as those arrived at by most of the witnesses hitherto examined, viz., that it is the general practice of merchant steamers in fogs, in the *open sea*, to go at full speed, unless and until the fog-signal from some vessel is heard?

(*Q.* 2.) If your experience agrees with that of the previous witnesses, would it, under the above circumstances, be, in your opinion, advisable for the present law, which directs—without any qualification as to geographical position—"that the speed be moderate in a fog," to be qualified to this extent, viz., that the following words be interpolated between the words "snow" and "go," so that the Regulation would run as follows?—"Every ship, whether a sailing ship or a steamship, shall, in a fog, mist, or falling snow [when in narrow waters or portions of the sea frequented by vessels], go at a moderate speed."

Note.—This would throw on the Captain or owner of any vessel, after a collision, the onus of proving, by sworn evidence in court, to the satisfaction of the jury and Judge, that the collision took place, not in narrow waters, and not in a portion of the sea frequented by vessels; and that her normal or full speed, or even a higher speed, was, therefore, allowable [not being forbidden] under the proposed amended law; or that, failing this proof as to position, that the speed was moderate.

4. The following questions are strictly confined to cases where the steamer is supposed to be (*a*) in the open ocean in a fog; (*b*) that the (at present) illegal practice of going at full speed had been adopted; (*c*) that the fog-signal heard indicated that the other vessel was a steamer.

5. For purposes of definition, it will be held in this inquiry that, as regards vessels unseen, owing to fog, snow, mist, &c., the expression "right ahead" is confined to a vessel B, some portion of whose body is exactly on the line of the keel of A; the word "ahead" is to be held to include 4 points, viz., from 2 points on one bow to 2 points on the other; and the words "on the bow" are to include 4 points on each side, viz., between 2 points and 6 points from the line right ahead, and the word "abeam" from 2 points before to 2 points abaft the beam.

(A.) *Alteration of the Speed of a Steamer (A) in a Fog on hearing a Steamer's (B) Fog-signal ahead, viz. (see our Definition), between 2 Points on one Bow and 2 Points on the other.*

There appears to be a consensus of opinion that in this case the ship's (A) way should be stopped promptly, and that if B's fog-signal be again heard ahead, and more especially if it appears to be nearer, that "stern way" should be given to A, taking great care to keep A's head towards B if possible.

(*Q.* 3.) Does your experience guide you to the same conclusion; or, if not, to what other conclusions?

(B.) *Alteration of the Speed of a Steamer (A) in a Fog on hearing a Steamer's (B) Fog-signal on the Bow, viz. (see our Definition), between 2 and 6 Points from right ahead.*

There appears to be a divergence of opinion in this case. Some seamen would (*a*) maintain their normal or full speed; some would (*b*) reduce to "moderate" speed; some would (*c*) "stop" until, in the two latter cases, reassured as to the risk of collision.

N.B.—One of the most experienced witnesses, when replying to the question, stated that he had been in command for many years of a mail packet, with a speed of 17 knots; that he crossed the British Channel every night; and that, on hearing a fog-signal on either bow, he never slacked or stopped, but maintained full speed and turned from the fog-signal, trusting to his great speed to carry him clear.

(*Q.* 4.) To which of these conclusions as to speed [(*a*) (*b*) (*c*)] does your experience guide you; or is there any other that you prefer?

(C.) *Alteration of the Speed of a Steamer (A) in a Fog on hearing a Steamer's (B) Fog-signal abeam, viz. (see our Definition), between 2 Points before and 2 Points abaft the Beam.*

There appears to be a consensus of opinion that, under these circumstances, no alteration should (at all events at first) be made in A's speed, nor under ordinary circumstances, unless and until A's course has been temporarily altered (see II *C*), and B brought right aft (if that change be considered desirable), when if the steamer B appears by the sound to be approaching, A's speed should be increased, if possible.

(*Q.* 5.) Does your experience guide you to the same conclusion; or if not, to what other conclusion?

II. Course in Fogs.

(*A.*) *Alteration in the Direction of the Ship's Head of a Steamer (A) in a Fog, on hearing a Steamer's (B) Fog-signal ahead, viz. (see our Definition), between 2 Points on one Bow and 2 Points on the other.*

There appears to be a consensus of opinion that, under these circumstances, no alteration should be made in the direction of the ship's head.

(*Q.* 6.) Does your experience guide you to the same conclusion; or if not, to what other conclusion?

(*B.*) *Alteration in the Direction of the Ship's Head of a Steamer (A) in a Fog, on hearing a Steamer's (B) Fog-signal on the Bow, viz. (see our Definition), between 2 Points and 6 Points from right ahead.*

There is a wide divergence of opinion among the witnesses; some hold that the most seamanlike course, or that least likely to cause

collision, is (*a*) to maintain the same direction of the vessel's (A) head; some (*b*) to turn towards the fog-signal; some (*c*) to turn away from it. Those advocating (*b*) stating as their reason, that in this way only can the narrowest section of the ship, viz., her cross section, be promptly opposed towards the other approaching ship, thus reducing the chances of contact to a minimum. They practice "stopping" and "going astern" immediately the helm has begun to act. Those advocating (*c*) admit the great risk incurred, but if in vessels of great speed and rapid turning powers (*e.g.*, double screws) assume that the other vessel is stopped or going slow, and rely upon turning clear ahead of her.

(*Q.* 7.) Which of these three steps, as regards the course steered [(*a*) (*b*) (*c*)], does your experience lead you to advocate, or do you advocate any other?

(*C.*) *Alteration in the Direction of the Ship's Head of a Steamer* (*A*) *in a Fog, on hearing a Steamer's* (*B*) *Fog-signal Abeam.*

There appears to be a consensus of opinion that, under these circumstances, no alteration should be made in the direction of the ship's (A) head, unless the other steamer (B), judging by the sound of her fog-signal, is "nearing," when A's head should be turned away from B, so as to expose the narrowest section to her, and thus reduce the chance of contact to a minimum.

(*Q.* 8.) Does your experience guide you to the same conclusion; or if not, to what other conclusion?

(*Q.* 9.) What is the general practice in the following cases?—When a steamer's fog-signal is heard in a fog ahead, or on the bow, and presumably far enough for action in time to avoid a collision. Is it the usual practice to act under Art. 23 of the Steaming and Sailing Rules, or under one of the others, according to circumstances? As, for instance, if a steamer's (B) signal is heard on the port side, is it usual in fogs for A to "keep her course," in compliance with Art. 22, on the assumption that B *is* or *may* be a "crossing ship" (see Art. 16?) And again, if a steamer's (B) fog-signal is heard on the starboard side, is it usual in fogs for A to attempt to "keep out of the way," in compliance with Art. 16, on the assumption that B *is* or *may* be a "crossing" ship? Or, in both cases, is it usual in fogs to always consider danger immediate, and act under Art. 23.

III. International Code of Fog-signals.

(*Q.* 10.) Are you of opinion that the practical advantages of attempting to establish and use an extended International Code of Fog-signals would counterbalance the disadvantages, some of which have been stated in evidence to be as follows?—

(*a.*) Encouragement to Captains to neglect precautions, as to course and speed, on the assumption that, if they kept on stating by fog-

signals the course they were steering and the speed they were going, that would be sufficient, and other ships would get out of their way.

(*b.*) Confusion and embarrassment arising from the difficulty a fog often experiences in transmitting sound accurately, sometimes retarding, sometimes accelerating it, and sometimes diverting it horizontally, sometimes vertically.

(*c.*) Increased confusion and embarrassment, if more than two vessels are within hearing of one another, and attempt to use an extended International Code of Fog-signals.

(*Q.* 11.) If you share the general opinion unfavourable to the establishment of a very extended and complete International Code of Fog-signals, and yet are not content with the limited power as at present of merely indicating the presence and the approximate bearing of ships in fogs, &c., do you think it would be well that steamers passing up and down and across frequented channels should be directed to indicate in fogs, by a marked difference in the sounds from their sirens, whether they are going one way or the other?

(*Q.* 12.) Or would you go farther, and provide a code which would encourage Captains to attempt to indicate their course as in one or other of the four quadrants, north, east, south, or west, or to points or to degrees, and their speed to knots?

(*Q.* 13.) In your opinion should Art. 19, which permits ships in sight of one another to indicate, by the steam whistle, whether they are directing their course to starboard, to port, or going full speed astern, be made to apply to signalling in a fog, as well as to when the ships are "*in sight* of one another," by leaving out the words, "which she has in sight."

I have the honour to be, Sir,
Your obedient servant,
H. Trueman Wood, *Secretary*.

Miscellaneous Remarks.

My experience of collisions in thick fogs is as follows, viz.: in four collisions in vessels (men-of-war) that I have commanded, viz., H.M.S. "Vixen," a steam sloop, twice; H.M.S. "Dauntless," a steam frigate, twice[1]—I have paid particular attention to this important question, and suggested methods for adoption on board our ships, to diminish the chance of collision in fleets of English men-of-war, some of which were adopted.

It is generally known that the vertical height of fogs is often so small that the mast-head "look-out" can look over them and see land, or neighbouring ships' mast-heads, but not so generally known that fogs can often be looked under by men in a boat towed alongside, or standing on the lower side steps.

[1] No blame was attributed to these two vessels-of-war by the Admiralty or any Court in either of the four collisions. One was with a man-of-war, three with merchant ships.

Every steamer should have a *powerful* fog-whistle (preferably a siren) worked by steam, and always, when used, to be used at full power, to prevent faulty estimates as to distance; and every sailing vessel a powerful fog-horn worked by steam or condensed air, replenished by a hand air-pump if there be no steam available.

The phrase "moderate speed" in the Fog Regulations is dangerously vague, and when vessels have collided in a very thick fog, no damages, if this term "moderate" is retained, should be recoverable by any vessel that was going ahead through the water at more than 4 knots (our fog rate in a fleet), unless the minimum speed necessary to make her manageable must exceed 4 knots, or except under special circumstances to be judged of by the Court. The minimum speed at which the ship is manageable in *smooth* water—the general condition in fogs—should have been ascertained by experiment on the measured mile trial and recorded in the official log.

The attention of captains of vessels should be drawn to the facts which, although self-evident, are often forgotten—(*a*) That no collisions could well take place in any fog in which all the vessels involved had stopped dead until the fog cleared, and indicated their positions to one another frequently; and (*b*) that no collision between two vessels in a fog could well take place if their direction from one another were ascertained with approximate accuracy, and provided they receded from one another either by one vessel going astern when the other was brought ahead, judging by the direction of the sound signal, or going ahead when the other was brought astern.

Moreover, as regards any vessel that has stopped, it may be assumed (*a*) that by so doing she has diminished, by one half, the prospect of collision with any other ship also in the fog, seeing that although she may be "run into," she cannot run into any other vessel; also (*b*) in case of a collision, as the "stopped" vessel cannot well be the offender, the prospect of her being found to be in default by the Court, and her owner having to pay damages, will be diminished in a still greater proportion, viz., to much less than one-half—in fact, to *nil*.

It is only on the assumption that it would be too strong a measure to oblige all vessels to "stop dead" in a thick fog, and remain so until it cleared (whether other vessels indicate their presence and proximity or not) that the necessity arises of considering whether it be advisable to make any additional rules or regulations (and if any, what?) for the management of vessels in thick fogs.

It is very true that in some fogs (see Report of Committee sent to America) sound is diminished in volume and intensity, while in other fogs the sound is intensified. It is also true that the direction of sound is sometimes wrongly indicated, and that two persons standing close together will have different opinions as to the direction. This points out the necessity of great caution, and the endeavour to obtain a consensus of many opinions as to the direction of the sound, when any change of course is in contemplation.

In my experience in the Baltic on one occasion, in a thick fog not distinguishable, however, from any other fog, the reports of 32-pounders

(charge 4 lbs.), on board H.M.S. "Dauntless," were not heard in our boats, although they were only two or three ships' lengths off.

In the Royal Navy, certain fog-signals may still be made with guns fired, at varying intervals. This is now forbidden with guns less than 64-pounders, if such are carried, charge 6 lbs. The charges of the guns used for this purpose, a few years since, were from 4 lbs. to 6 lbs., and the reports were ordinarily heard at considerable distances —two to three miles. Owing to changes in the armament of our line-of-battle ships (with from 74 to 120 guns firing such "charges") to ships of late construction, with armaments consisting ordinarily of only four very heavy guns, quite unsuitable for fog-signal guns, supplemented by a few very light guns for saluting purposes with charges of 1 lb. to 2 lbs., fog-signals (with guns) in Her Majesty's Navy are now made at a great disadvantage unless they happen to have at least two 64-pounders.

Viewing the question of risk of collision in thick fogs, apart from any existing regulations, and in obedience merely to the dictates of seamanship, two vessels made aware of one another's presence in a fog, will, as a general rule, reduce the probability of collision by making their courses parallel, to which A will frequently contribute by bringing the other vessel (B) ahead if the latter appears to be on the bow, provided they are not very close to one another, or astern if she appears to be abeam, and closing.[1]

The permission to "depart from the Rules to avoid immediate danger" (risk of collision being presumably one of the dangers), granted by the Regulations, Art. 23, should be applicable to vessels not in sight, but in *hearing* of one another in a fog, seeing that the Court, as the Regulations now stand, would probably condemn any vessel (A) that collided with another (B) in a thick fog, if she (A) had altered course or speed after ascertaining by sound that B was on her (A's) port side, and, *vice versâ* (2) the Court would probably, as the Regulations now stand, condemn A, if, after hearing B on her starboard side, she (A) did not steer wide of B in order to comply with the Regulations, and (regarding B as possibly a crossing ship) to keep out of B's way, whereas, according to the dictates of seamanship, risk of collision will be least if both ships contributed to making their courses parallel, viz., either identical or exactly opposite to each other, according to circumstances. I have reason to believe that this view is not accepted by the Board of Trade, and that Rule 22 rather than Rule 16 would probably be considered by them as governing the action of ships in fog.

Experiments should be made, as suggested by Sir W. Siemens, to ascertain whether a fog-ear could be constructed on the principle of the telephone, and conveniently placed above the bridge so as to indicate not only the presence of the other vessel, but also her direction, by intensifying the sound of her fog-signals.

It is expedient to make an empirical "fog-scale"[2] on board ships

[1] An analysis of all the fog (two steamers) collision cases (29 in number) adjudicated on in the Admiralty Court in 1872–81 confirms this view.

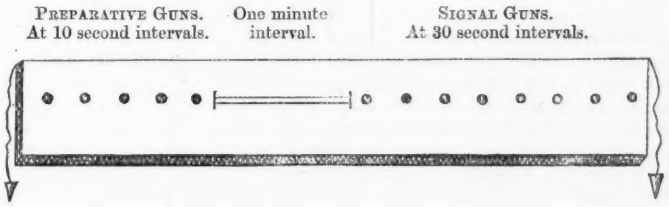
[2] The comparative visibility in the daytime of objects (such as printed letters on

from 0 to XII as is done for the wind, as a guide to Officers in charge when to diminish and when to increase the speed in a fog.

Experiments should be instituted as was suggested by the Fog Committee of some years back to ascertain whether sound can be as well or better transmitted under water, than above, from one ship to another on the open sea.

There should be daily and nightly exercise of *fog*-signals in all ships-of-war, in addition to an hour's exercise every night of the *flashing light* signals, whether in fleets or when detached, seeing that the Captains may have to communicate promptly in fogs, and on the most important subjects, when the flashing light can only be distinguished occasionally, if at all, and then with difficulty, with, as a consequence, great liability to mistakes.

A piece of wood fitted like this has been found a useful aid in recording fog-signals with guns. I suggested its adoption when in the Channel Fleet, and hear that it is now in general use in that fleet; it would be useful on all stations.

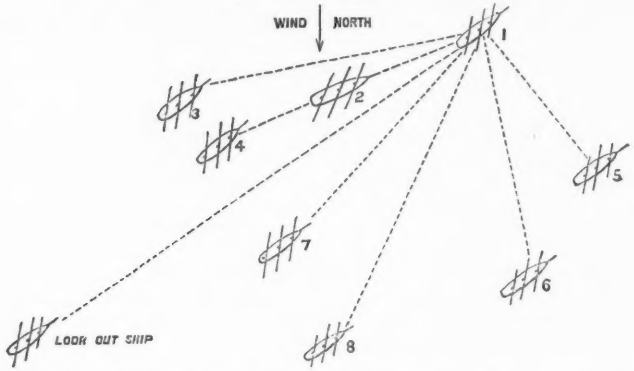


The left hand peg is entered when the last *preparative* gun is heard, and the right hand peg when the last *signal* gun is heard, and thus the very common difference of opinion as to the number of each description of gun (preparative guns and signal guns) is got rid of.

There should be a good clock in the bridge house, and it should have a "second" hand. The late alterations in the fog-signals altering the interval is a great gain.

a board) on the forecastle or foremost turret when seen by an observer aft, and at twelve different fixed distances, and at night time of a ray of light in the same place, would be a useful aid in fixing this empirical scale.

Plotting the Approximate Places of Ship in a Fog.



The approximate place of each vessel in a fleet can be approximately fixed in a fog, if the following plan is adopted. The flag-ship intimates by say No. (at present an unused number), or by *one* gun fired say ten minutes after the half-hour fog gun, that she wishes to ascertain the approximate position of each ship of the fleet. The ship that has Fleet number 2, fires one gun exactly two minutes after she hears the gun of the "*distance*" signal, and the ship that has Fleet number 3, fires one gun exactly three minutes after she hears the gun of the "*distance*" signal, and so on. It is evident that the flag-ship will find, on noting the interval between the time when she fired the gun of her "*distance*" signal and when she heard the reply of each ship, that there is an increment of a certain number of seconds over and above the number of minutes interval ordered, increasing according to the distance of the ship, and this is due to the time occupied in the flight of sound. The increment in seconds will, if halved and multiplied by 374 (the average number of yards occupied by sound in travelling during one second), give the number of yards the ship is off. The approximate bearing on which each gun is heard should be noted, and then the approximate position of every ship can be plotted off in two or three minutes, and the name of any missing ship will be known. A stop watch marking tenths of seconds would add to the accuracy of this method; they are not uncommon now. An error of a second in firing the reply gun introduces an error of about one cable in the half distance, but heavy guns can be heard in some fogs two or three miles off, and it may be worth while to know the position of each ship approximately, within say half a mile (which is allowing for an error of five seconds in the firing of the gun).

Supplementary Notes A and B.

A. All aids to "keeping station" in a fleet in a fog are valuable as aids to preventing collisions.

Admiral Cator's Fog Alarm Buoys.

If when a fleet is involved in a thick fog it changes its formation, the risk of collision is considerable. If circumstances permit, it is safest to continue the *formation*, the *course*, the *speed* (which the Regulations say should not exceed 3 to 4 knots, unless under special circumstances) until the fog clears. But it is, of course, often absolutely necessary to change the formation, the course, and sometimes the speed. In the olden time when we had sail alone, the safest formation to give the fleet the best chance of keeping together was to have the fleet in two lines on a wind. If the wind shifted, the ships "came up" or "fell off" together, preserving their relative positions, and all of the ships, if well handled, remained within hearing of the Admiral's half-hourly gun until the fog cleared off.

In a fleet under *steam alone* in peace time, the best formation in moderate weather to secure cohesion and prevent collisions is probably a single line, the vessels keeping touch by being within *hearing* distance of one another. Admiral Cator's fog buoy, of which a drawing is on the wall, which is issued now to all ships of size in the Channel and Mediterranean fleets, assists in maintaining cohesion; it is veered astern, and its bell, if heard, tells to a following ship the situation of her next ahead. It has been found very useful to ships in a fleet in moderate weather, when the speed does not much exceed the authorized fog speed—3 to 4 knots.

Archibald Smith's "Straight Line" Deviation Table.

I have said above that when the fleet in a fog is under sail on a wind, the ships will maintain approximately their relative positions, provided each ship keeps under the same sail as she had when the fog came on, when she was presumably in her station. With handy ships and experienced Officers it was marvellous how closely the formation was preserved in fogs, aided by the Admiral's half-hourly fog gun, even with considerable shifts of wind; but in a fleet, *under steam alone*, in a thick fog, particularly if the fleet is not in one line, considerable alterations in course have led not infrequently to something very like dispersion.

I have seen a fleet of eight ships in two lines off a harbour mouth, and on the point of being formed in one line to enter the port and anchor there, dispersed to every part of the horizon. Two hours after the intention of entrance had been abandoned, and the signal "alter course eight points to starboard" had been made, two ships alone of the whole force were found at the end of that period "in station" on the flag-ship, viz., the leader of the second line and the "next astern" to the flag-ship. The signal made with the small brass signal guns was not heard by some of the Captains, was misunderstood by others, and the courses steered by some ships that made out the signal were not really eight points to starboard of the old course.

The corrections for deviation of the compass are different in every ship (if the compass has not been entirely corrected by magnets), and if two or more ships steering exactly in the same direction alter course by signal to the right or left a given number of points, it will be found that (when steadied) they are not steering parallel courses if the number of points of alteration are merely measured on the standard compass, and the two courses are not corrected for deviation. This was a perpetual source of annoyance in fleet tactics, until a suggestion made by me when second in command of the Channel Fleet was adopted, and a deviation table placed in each bridge house formed on Archibald Smith's "straight line" method, which prevents the possibility of making mistakes in correcting courses for deviation. A specimen of this table is on the wall, and when any alteration of course is ordered to be made in a fog, the aid of this table should be called in; mistakes in the course, leading to dispersion, may, especially in war time, end in disaster, either by collision with a friend or capture by the enemy's fleet.

Sir W. Thomson's Compass.

When this has been supplied and, if there is no correction for deviation, recourse to the above "straight line" table is unnecessary, but Sir W. Thomson's compass is not as yet invariably supplied.

The Revolution Indicator.

Among the later inventions provided for our use by the Admiralty, a very valuable one, and especially in fogs, is the *revolution indicator*. I persuaded the Society of Arts a few years since to offer their gold medal for the best Revolution Indicator. This led to a close competition, over 100 more or less ingenious contrivances were submitted. A revolution indicator invented by Mr. Hearson, an engineer R.N., won the gold medal; but an instrument invented by Mr. Trower, who was at that time associated with my lamented friend Mr. William Froude, is now the favourite, and is supplied by the Admiralty.

We have had revolution *counters* almost from the beginning, and very useful they are as a *register* of the revolutions; but what was required was a revolution *indicator* which, with a face on deck and a face in the engine-room, would show to the engineers in charge of the engines, and to the Officer of the watch, how many revolutions per minute were being made; this I am told is successfully done by Mr. Trower's revolution indicator.

To those present who have been in a fleet in a fog it is familiar that it is of the very essence of success in "keeping station" in a fog that the Admiral should have signalled at what number of revolutions he intends to maintain his flag-ship's engine, and that each ship present should (by use of their coefficients) have ascertained how many revolutions their engine is to be kept at, and that then these revolutions be accurately maintained in each ship. Unless this is done with great care the ships soon get out of station, and of course if a ship is once out of hearing distance in a fog she is nowhere,—hence the great advantage in fleets in fogs of Trower's revolution indicator. It at the same time constrains the engineer to keep the engine at the prescribed revolutions, aids him to do so, and instantly informs the Officer of the watch of any variation.

B. All aids to the ascertainment of the exact geographical position of a fleet when making a passage in a fog are valuable as an assistance to preventing collisions, by maintaining the regularity of the progress of the fleet with the least possible amount of alteration of course, of speed, of stoppages, and of inaccurate landfalls.

Sir W. Thomson's Sounding Machine.

Sir W. Thomson's sounding machine (a lecture on which, written by my friend Captain Claude Buckle, will be given in this theatre on Wednesday, 18th instant) is also invaluable, but more especially in fog, provided of course there are some sufficiently well marked and defined variations in the soundings on the chart. This sounding machine should be supplied to every man-of-war as it is to every ship in the principal mail steam lines, and practice in the use of it enjoined. As with everything else, so with this sounding machine, constant practice, and practice alone, will "make perfect," and prevent loss of the instrument when its aid is most needed.

Latitude and Longitude by Dead Reckoning in Fogs.

There is another point to which a passing allusion may be useful to my junior brother Officers. Let us suppose that in a fleet of men-of-war a fog comes on sufficiently thick to obscure the horizon or the heavenly bodies, but not to prevent tactics, and lasts for some days. If the fleet is making a passage, say, to the Mediterranean, the flag-ship leading the weather line, the flag-ship alone can depend with any approach to accuracy on the position by *dead reckoning* recorded in *her* log-book being fairly accurate. All the other ships are changing their speeds, stopping, altering course frequently, while the flag-ship perhaps during the whole time steers steadily on her course and goes at a fixed speed, until at the end of, say, three days, there will be a very large margin of uncertainty as to the position by dead reckoning of each of the ships other than the flag-ship. This makes it more than ever important that the flag-ship indicate her position by dead reckoning to the

fleet more frequently than at noon, and that the flag-ship's position by dead reckoning at noon should give a last departure to each ship, and also that each ship should recognize, if detached in the fog, that the flag-ship's last signalled latitude and longitude by dead reckoning will for the above reason be much more trustworthy as a departure than her own.

When the Latitude and Longitude is Signalled at Noon from each Ship it should invariably be stated whether this is by Dead Reckoning or from Observation.

An incident that occurred under my own observation when second in command in a fleet of ironclads in a thick fog, obscuring the horizon but not the sun, pointed out the great importance attaching to the following precaution, viz., that every ship in a fleet, when signalling her latitude and longitude at noon in reply to the Admiral's signal, should also invariably state whether the latitude and longitude were by *dead reckoning* or by *observation*, and if the latter, when such observation was taken and its nature. At noon, as the horizon had been obscured for 36 hours, the latitude by dead reckoning and longitude by dead reckoning ascertained in a fleet of eight vessels were duly signalled by and to the flag-ship, putting us 50 miles off shore. All the *longitudes* agreed fairly with one exception, that of my second astern, which indicated a longitude implying that we were 30 miles nearer the land, and only 20 miles from the shore. No attention was paid to this; the evidence of the majority, 7 to 1, as to the longitude by *dead reckoning* was naturally and rightly accepted as far outweighing the evidence of only *one* ship. It was easily assumed that this one ship was in error in her dead reckoning. The fleet was at noon under sail, heading in shore, and supposed to be at 50 miles distance. The intention was to wear off shore at 4 P.M. No suspicion was entertained of any danger. The sounding (we had several hundred fathoms of water under us) afforded no clue to the position until 4 o'clock, when the lead suddenly indicated shoal water, and a lift in the fog betrayed the fact that we were over 30 miles in shore of our supposed position, and only a few miles from the beach.

A current of an unexpected character had set us towards the shore over 30 miles in that 36 hours of fog. I was leading the lee line, and on return to harbour a few days after, I sent for the Navigating Officers of the four lee ships (my division) and their work books, to investigate the matter, viz., their strange discrepancy as to the longitude by dead reckoning, the seven ships being in error, and the single ship right. The reason was soon evident. The "Master" of that single ship had for an instant seen a *true* horizon, and got an *observation* by *chronometer* on the forenoon of that day. The longitude he had signalled at noon therefore was the *true* longitude by observation. All the seven other ships had signalled longitudes by *dead reckoning* with the most unusual set of the current, viz., 30 miles in the 36 hours, towards the shore ignored. Had it been the rule then, as it may be now, that invariably when in a fleet the latitude and longitude has been signalled at noon, it is also added immediately by each ship whether they are by *dead reckoning* or by *observation*, my second astern would alone of the eight ships have indicated that her longitude was by *observation*, all the rest would have indicated longitude by *dead reckoning*, and as a consequence, we should have stood off shore many hours earlier.

How to make due Allowance for the Set and Rate of Tides off the English and Irish Coasts when Fog prevents sight of the land and the soundings are misleading.

Our ships of war have as far as possible to ignore fogs, especially on our own coasts where they are frequent, and when we have the aid of local pilots this may be done with comparative safety; but local pilots are not always available, and time cannot always be spent in obtaining them and waiting for them. A careful consideration by the authorities of the following suggestion would occasionally make us almost independent of local pilots. Take, for instance, the tides in the St. George's Channel and the Irish Sea—a ticklish piece of navigation in a fog. It is well known that the instant of high water is synchronous throughout the whole of the

Irish Sea and St. George's Channel. Hence it is at the same time at Liverpool as at the Old Head of Kinsale—and this is also the case with low water. This fact may be made of great aid to ships navigating between these localities in a fog—provided the Hydrographic Department will step in to their assistance.

Assume that a ship after passing the Old Head and taking a trustworthy departure from it is immersed in a fog until she reaches the entrance to the Mersey, what aids can she previously obtain towards steering courses duly corrected for set and rate of tide?

Off the Old Head a good watch or hack chronometer should be temporarily taken on duty as a tidal watch, and set to show the tide time at Liverpool ascertained from the Nautical Almanack when off the Old Head previous to the voyage. This alone would be of great service in aid of correcting the soundings—but it would be of much greater use if the Hydrographic Department would bring out eleven tidal charts of the St. George's Channel and the Irish Sea—Nos. I and XII would be identical—and bind them up in a book. These should be compiled from the most accurate and latest surveys. Chart O should show the soundings throughout the St. George's Channel and the Irish Sea at dead low water spring tides, and the set and rate of the tide (if there were any) at the time of low water at Liverpool, viz., at 0 o'clock on the tidal watch. Chart I should show the soundings at *one* hour after dead low water spring tide, and the set and rate of the tide (if there were any) at *one* hour after the time of dead low water at Liverpool; this would be at 1 o'clock on the tidal watch.

Now, if these twelve charts are placed accurately one over the other, it is evident that the ship's place on one of the charts—say No. VI (selected, say, when the tidal clock shows 6, and because showing 6 off the Old Head) can be pricked through to the next chart VII, when the tidal clock shows 7; and the correction of the place of the ship for time and distance run by D. R., supplemented by the direction and rate of the tide for one hour found recorded on that chart, would give the correct place of the ship at 7 (tidal time). In this way (assuming that the direction and rate of the tide is given with fair accuracy on the eleven tidal charts)—*and the position checked by soundings*—good way can be made up the St. George's Channel and the Irish Sea, clearing the dangers on the port and starboard hands until the bell of the north-west bell-buoy off Liverpool be heard.

The mere fact of having to compile eleven tidal charts for St. George's Channel and the Irish Sea would at once, I have little doubt, lead to the discovery that in many parts much more accurate tidal data are required and could be obtained, and that fresh and exhaustive surveys would be necessary. I submitted the above suggestion about twenty years since to Professor Haughton, whose works on the Irish tides are considered as "standards," and he strongly recommended its adoption; but it has slept in the pigeon-holes in Whitehall; perhaps its slumbers may be disturbed by these observations of its parent.

The Speed that is most Economical in Fuel per Mile.

The speed which the Admiralty have ordered ships in a fleet in a fog not to exceed, viz., 4 knots, is fortunately the speed, or within a knot of that speed (about 5 knots), which careful experiment has proved to be about the average speed which is most economical in *consumption* of *fuel per mile*. Their Lordships were pleased to adopt throughout the Navy a recommendation of mine, and embody it in a circular, No. 45 S (Fleet Circular, 26th Nov., 1880), directing all ships to ascertain by a simple method described and previously adopted by me (and now made obligatory in all ships), the speed that is most economical in fuel per mile.[1]

Each ship has a speed that is most economical in fuel per mile, and these speeds vary under different circumstances and in different ships, but the average is probably 5 knots. To ascertain the speed of *a fleet* which is most economical per mile, a speed more than the most economical speed of some of the ships, and less than that of others, will be a very important question which our Admirals of the future will often in

[1] Mr. Robert Roughton, Engineer, R.N., first suggested it.

war time have to ask anxiously of their Captains of the Fleet, Flag Captains, and Inspectors of Machinery Afloat; and when involved in fogs and making passages, this speed will no doubt be carefully maintained if the supply of coal is doubtful.

If our supplies of coal were inexhaustible, or if our fortified coal depôts were to be found, as they ought to have been by this time, whenever possible, at intervals of about 1,000 to 1,500 miles on all the great tracks of marine commerce, this watchful anxiety over the coal consumption would have been less necessary than it will now be in war time, with broken links in our chains of coal depôts.

Finally, I commend to the attention of my young brother Officers in command the great importance of constant, that is, daily and nightly exercise of all executive Officers and men, not only in *flashing light*, but also in *fog* signals in all ships in commission, whether in fleet or single, whether in harbour or at sea, both with guns and steam whistles or sirens.[1]

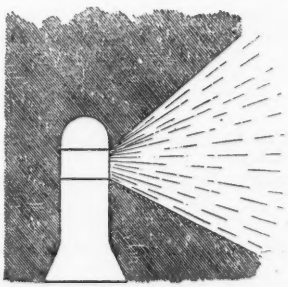
Memorandum by a Captain of a Transatlantic Steamer.

In passing over the Admiral's tests for density of fog, I omitted to send him a test which I consider the best and safest, and one that, so long as the green light is burning, never fails. If he has any doubt on this, he can easily test it by getting a starboard side light, and taking it into his garden whenever it is foggy; if there is any smoke in the fog, it will not show so well as in a fog pure and simple—the condition at sea. I enclose my own test for fog.

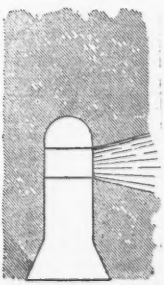
8th December, 1883.

Fog Test.

During the night, the starboard side light is the best and only sure test of the density of fog. Be there ever so little haze, the rays from the green light will show it by illuminating the particles of moisture in the atmosphere; this illumination will be but faint, and extend from two to three feet from the lamp;[2] but as the haze increases and thickens into fog, the illumination of the particles increases, and the rays will lengthen out and spread till they extend fully fifteen from the lamp. This can be well seen from the forecastle, but the best position for observation is abaft the tower, or lamp screen; to a person in this latter position, the effect is as follows:—



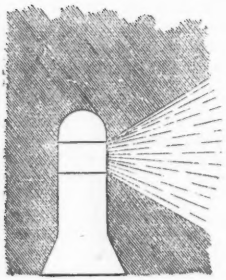
DENSE FOG



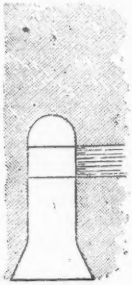
THICK HAZE

[1] In single ships these signals should be exercised between the forecastle and poop.

[2] In very fine rain the rays from the green light are just discernible, but not in ordinary rain.



FOG



HAZE.

The mast-head lamp will also show this effect, but not to the same extent; the rays from the red light are only faintly discernible in very dense fog.

Guide to Discussion.

The following suggestion of points for consideration is not intended to restrict the discussion of the Essay, but some of the points are brought into prominence for the convenience of those gentlemen who wish to confine their remarks to the more special subject of the lecture.

I. *Speed of Steamers in Fogs.* In the International Regulations we find—

Art. 13. Every ship, whether a sailing-ship or steamship, shall in fog, mist, or falling snow, go at a moderate speed.

(1.) Is the above regulation satisfactory? Seeing that it appears to be almost universally broken *on the open ocean* by the steamers of the principal lines of steam packets. With the full knowledge of the Directors, but no doubt against their orders, these vessels appear to be continually propelled in fogs at speed other than "moderate," frequently at *full speed.*

(2.) If the present regulation be satisfactory, should it be more strictly enforced, and how?

(3.) If the present regulation be not satisfactory, what are the alternative alterations which might be considered by the Board of Trade, or by an International Committee of experts, with a view to the improvement of the existing regulation?

(4.) What are the relative advantages and disadvantages of these alternative alterations?

II. *Alteration in the Direction of the Ship's head of a Steamer in a Fog on hearing the Fog Signal of another Steamer*—

Definitions, but merely for the purposes of this lecture, as they are susceptible of improvement.

Let A and B be two Ships. If B is described as

(*a.*) *Right Ahead*; it means that the ship B has some portion of her hull in the (forward) line of A's keel.

(*b.*) *Ahead*: it means that B has some portion of her hull within *two* points of right ahead of A.

(*c.*) *On the Bow*: it includes all cases in which B has some part of her hull over *two* points, and under *five* points on either side from the direction of the keel, looking forward.

(*d.*) *Abeam*: it includes all cases in which any part of the hull of B is between from *three* points before to *three* points abaft the "right-abeam" line.

(*e.*) *On the Quarter*: it includes all cases in which B has some part of her hull between *three* and *six* points abaft the beam of A.

(*f.*) *Astern:* it means that B has some portion of her hull within *two* points of right astern.

(*g.*) *Right Astern:* it means that the ship B has some portion of her hull in the (aft) line of A's keel.

What change, if any, in the direction of the head of a steamer A circumstanced as above (*e.g.*, in a fog on the open ocean), should be made on hearing the fog-signal of a steamer B in either of the following directions? Distinguishing between the cases of hearing the signal on the *starboard* or on the *port* side.

Right ahead.	*On the beam* { On starboard side. / On port side.
Ahead.	*On the quarter* { On starboard side. / On port side.
On the bow { On starboard side. / On port side.	*Astern—Right astern.*

III. Should there be an extended code of fog-signals for international use to indicate *speed* and *course?*

What are likely to be the advantages and disadvantages of such a code?

If adopted, to what extent should its use be obligatory or optional?

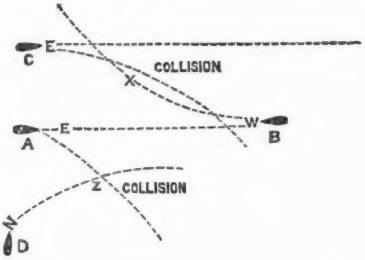
Captain FREMANTLE, C.B.: There are one or two points which occur to me on which I should like to say a few words. I think the subject has been gone into very fully, and as far as I can judge very clear views have been put before us as to the opinion entertained by the very important Committee, of which Admiral Ryder was Chairman, as to what course should be adopted. I think it is rather disappointing that the answers of the captains are not recorded. I do not know whether Admiral Ryder would add that. Perhaps he will tell us in his reply why the answers were not reported, because it is extremely interesting to know what the opinions of the merchant ship captains may be on such a subject. I think we can most of us corroborate from our experience the fact that at all events the large American liners generally cross the Atlantic at their utmost speed, whether in fog or not, and when we are on the coast of Ireland, or in such places as we know are in the direct track of these vessels, if we hear a fog-signal we have a general idea that a ship may be coming down upon us at great speed, and there are circumstances in which it is a very difficult question for the Captain of a man-of-war to know how he is to act. There are one or two points on which I should certainly be inclined to differ with Admiral Ryder. I am inclined to think we ought not to reduce our speed too much even in a fog. It is all very well in a fleet in which you are protected by the ship ahead or astern, or which at all events goes on its way in a sort of independent manner but at very low speed; but for a single ship there is some danger when going at such a low speed as 3 or 4 knots. I am aware that I am speaking in contradiction to what are the instructions on the subject, but I should prefer to go at 5 or 6 knots in most ships, and I think it would be a pity to limit it so low as 3 or 4. Then I think there is an advantage (I once took a little trouble in writing something on that subject) in one ship only keeping out of the way. I think when you know that a vessel is on the starboard hand you may feel moderately safe, because it is your duty to get out of her way; and when you have a ship on your port hand, you may feel moderately safe in continuing your speed, because you feel that it is her duty to get out of your way. In that I gather that I rather agree with the opinion of the Board of Trade than with that of a good many naval Officers. I have just a word to add on Admiral Cator's buoy. I think we all found in cruizing in the Reserve or Channel Fleets the advantage of the buoy. I was one of those very much in favour of a buoy towing astern. We tried it originally with some of Harvey's buoys, which were not of much use for the purpose for which they were supplied, as we thought. I remember on one occasion making Captain Cator very angry by fishing up the buoy that he was carrying astern of the "Defence," and endeavouring to improve it by attaching a buoy to it, to give it more buoyancy; but now I believe he has brought it to great perfection, and I shall be very glad to be astern of him again, to see how it works.

Captain LINDESAY BRINE, R.N.: I need not apologize for rising, because the question of fogs is so interesting to all those who command ships, that the few words I have to say I hope will be found of some purpose. I shall confine my observations chiefly to pages 737 to 739, first alluding to the question of the high speed of ocean-going steamers. It is unquestionable, as Captain Fremantle has said, that on the great lines between England and America, in fogs the steamers are apt to go at speeds varying from 12 to 16 knots. But I believe it is also their custom when they get into narrow channels to reduce the speed to 6 or 7 knots. This is what I understand to be the usual practice, and therefore the only point to consider is whether there shall be any regulation which shall prevent or check this high speed being kept up in the open sea in fogs. If you were to permit a fixed high speed, to be authorized by law, the probability would be that a bad look-out would be kept, because the very thing that causes an exceptionally good look-out to be maintained is the fact that it is known that the speed is in contravention to the law, and therefore a very careful and good look-out is kept. If this is done, together with high speed, it will, I have no doubt, lead to a much greater prevention of collision than would be the case if a law was made permitting steamships to go at high speed in fogs in the open sea, and therefore in that sense there is a considerable advantage to be derived from the preservation of the *status quo*. I think it would be very desirable to have defined, in any future law, a certain homeward and outward-bound course in those latitudes where fogs are frequent. With regard to steamers trading between North America and England, this is a most important law to consider. The principal lines of steamships practically do keep an outward and homeward course so defined as to make collisions very improbable. But when they come into narrow waters there is no such custom, and it would be very desirable if on the coasts of England and North America there should be some understood position where vessels are to come in on a certain track and to go out on a certain track, and these tracks should be well defined. It would then be known that when any collision took place, soundings would be taken, and the vessel in the wrong position would be liable for the damage done. I think that is very reasonable. With regard to signals in fogs, my experience is that many signals are a mistake, and tend to create confusion. I would not give the power to merchant steamers to make signals of position or of alterations of course, but I would have this: every steamer should have a siren or steam whistle, having a high note and a low note. I should mention that my attention was particularly drawn to the practical usefulness of this by Sir William Thomson. The vessel having the high note should be the vessel going outward, and the vessel with the low note the vessel going homeward, and with these two signals any vessel would at once know that the other one was probably proceeding on a known track, and steering a known course, and that would very much modify any supposed necessity for a multiplication of signals. As regards hearing signals, it is very often impossible to say whether a signal comes from the starboard bow, from the port bow, or abeam. As to stopping dead in a fog, I remember that almost the worst collision that has happened of late years in a fog was one which took place where the vessel which was struck was stopped dead, and the other vessel was proceeding on a trial trip at moderate speed. The result was that the moving vessel was not found to blame, and I think the vessel that stopped *was* considered blamable. In conclusion, I would observe that there are two points I wish chiefly to bring out, namely, the necessity of having a homeward and outward-bound course in narrow channels, well defined, and a high and low note signal, to distinguish whether a vessel was going outward or homeward.

Mr. LIGGINS: The subject of fog signalling and fogs at sea has been forcibly under my attention and observation since forty-three years ago, when I spent a day on the top of Margate sands before the Tongue Light Ship was placed to indicate the Prince's Channel, which is now in universal use instead of the old Queen's Channel. That was on a fine day, and therefore there was no danger as to the safety of the ship; but from that day up to this hour I have, as a rule, watched the cases reported in connection with fogs at sea, and have examined into the danger arising from them. The last fog I was in was on Thursday last week, in a very fast steamboat in the Swin, at the mouth of the River Thames, and three

weeks ago in the Gulls, on the edge of the Goodwin Sands. I would draw the attention of this meeting particularly to this fact, that most gentlemen in scheming devices for avoiding collisions at sea confine themselves to two vessels, whereas the fact is that between the Swin Middle and the Mucking Light last week I counted over 500 vessels, a great number at anchor. They were of all sizes, from one of the P. and O.'s boats, which I met, coming down at a very moderate speed, going to Calcutta, to ships of 1,000 tons down to smacks, and vessels of 40 and 30 tons. This fog only lasted less than half an hour. The necessity for moderate speed in fog, in my mind, is limited to pilot waters. I say in pilot waters to distinguish what I mean from the great ocean. I have had considerable experience in the great oceans, and am constantly hearing the opinions of the commanders of the fine ships that traverse the ocean, and within my recollection I cannot say that I ever heard of an accident arising from high speed in the ocean, except on one occasion, and that was where a Cunard captain—an old friend of mine, long since dead, something like forty years ago—ran over an emigrant ship on the banks of Newfoundland, drowning 600 persons. It was not the fault of that captain, but it was the fault probably of the other ship, which had ceased to give any signals whatever. I have with that captain crossed the banks of Newfoundland for three days and three nights in fog, and at the highest speed capable, and we arrived in Liverpool within an hour of the appointed time; therefore we, of course, did not even slacken in the fog. I do not see the necessity for an ocean steamer slackening in a fog, for this reason, that you may very often cross the Atlantic and never see a vessel. I have done it many a time between England and the West Indies, but not on the New York and Liverpool route, and if you do, she is quite sure to be sounding her signals, and so are you; therefore the result is that both vessels stop, and no danger arises. That is the reason why these fast vessels crossing the Atlantic do not come into collision and drown people, for if they did we should hear of it. These same ships invariably stop the moment they get into pilot waters. One column of the *Times* to-day furnishes two cases. One was a ship that did not stop, or was out of her calculations—a steamer going from the West Indies to New York, which ran ashore on Long Island. The other was a no less important vessel than a Cunard steamer, which was reported as having run on the coast of Ireland, but she was going "dead slow" at the time. She knew that in a dangerous locality like that she must act with caution, and I have never found ocean captains do otherwise. I have gone over and over again between the West Indies and New York at the highest speed the vessel was able to go, and without the slightest chance of fear of any collision. I have done it in ships of my own under sail going from 12 or 13 or 14 knots; and I should do it again if I were in a yacht to-morrow. I should go at full speed in a fog, relying upon the security offered by my fog-signals, and I should expect that every other vessel would do the same. I have taken a great deal of pains to analyze the Report of the Society of Arts, and I quite agree with the conclusion at which the Committee arrived—that they did not recommend any one of the proposals put forth in that voluminous Report. The words of the Committee are: "The Committee feel much indebted to many gentlemen who have submitted these suggestions, but they do not consider themselves in a position to recommend any one of the systems described in preference to the others." Is there a single suggestion in the Report that is as simple and clear as the rule as it now exists? I think not. I have taken the trouble to analyze this Report. I have taken out every single case, and what do we find? There are seventy-nine suggestions, and fifty-one of these recommend compass-course signals, which are of very slight use, if any, in a fog. It is said that if one vessel can telegraph to another by any system (the Morse alphabet or any other plan) which way she is going, that the other might get out of her way. Now, here is a vessel steering east and another vessel steering west. The first vessel telegraphs that she is steering east, and the other that she is steering west. The question arises, What are these two ships to do? It is quite clear that if the vessels are in certain positions, and they keep on their course, they will go clear of each other; but as we cannot tell the course from which a fog-signal comes, it becomes a very perplexing matter, and it is quite evident that if being in certain positions they keep straight on, they will come into collision. "Oh," says Mr. McFarlane Gray, of the Board of Trade, who, by-the-

by, to do him justice, said he did not profess to be a seaman, "let them port their helms." Well, they do port their helms, and where are they? They are there in



collision [diagram]. Then there is another case; one ship telegraphs to another, "I am going east," and another, "I am going north." Well, she may, or she may not, hit the other ship if she does not alter her course. You cannot tell in a fog. "Oh," says Mr. McFarlane Gray, "they must both port." Well, there you are in collision [diagram]. Now, what is the use of a compass course? I do not speak of this without having tried it at sea in fogs. I was in a fog last week, and we slowed down, and many vessels of course brought up. It was a fog which did not last half an hour. I was in a fog three weeks ago in the Downs, and there all the vessels brought up of every size. The fog did not last an hour in that case; and I understand that from the cliff the vessels' masts were well seen, which confirms, what we all know as seamen, that you can often see the upper part of a ship in a fog, and you can often see in a boat when you are on the water. The fog may be only some 20 feet deep, and may perhaps not come within 10 feet of the water. That disposes, according to my mind, of the uselessness of 51 out of the 79 recommendations, leaving 28; against 22 of these I have thought it right to put the word "useless," leaving 5 suggestions only in this important Report worth notice, and I think the gallant Admiral does not disagree with me as being worthy of consideration. We have therefore 5 out of 79, and I have written against No. 25, "Practical and wise;" No. 28 already in practice in all vessels; against No. 35, "Good advice, but partly the rule;" against No. 54, "Not equal in value to the present rule;" and against No. 75, "The only valuable suggestion as addition to the present rule;" and that one word expresses with emphasis—the word "stop." Now I have taken the pains to ask the most experienced men in the world about this matter, and when I say the most experienced men in the world, I think every seaman here will agree with me that the North Sea fishermen stand A 1. The master of a North Sea smack is perilling his life at all hours of the day and night in all weathers. Such familiarity almost breeds contempt of danger, but what do they all say?—that vessels ought by law to be compelled to stop, and in anchorage-ground really to anchor, so that there may be no mistake about it. You will find that that was a reckless statement made by the captain of that Channel steamer carrying the mails who dared to say that he went across the Channel at full speed in a fog, trusting to his ears to tell the direction in which the sound of any fog-signal came. I have crossed the Channel so many hundreds of times that I know the practice. Some years ago I was within the length of that table from being, in one of the Calais mail boats, on the rocks at the foot of the South Foreland Light. We were in mid-day, going dead slow, and were able to turn her astern to prevent touching, otherwise we should have come in without a bowsprit. Therefore I do know that they do not risk their vessels and the lives of their passengers by such reckless navigation. It was, I think, two years ago that I was going from Southampton to Havre in one of those well regulated boats belonging to the South-Western Railway Company. We started at 12 o'clock at night, and as soon as we got outside the docks

we could no longer see. We anchored there until 8 o'clock the next morning, and then crossed the whole of the British Channel at full speed. We could see a vessel 3 or 4 lengths off, and there was no danger in going at that speed, as we did not all day hear a fog-signal, because we could stop and reverse in a moment, the ship being a fine paddle-wheel vessel; but you could not attempt that with large ocean steamers which have screws. The screw is most unwieldy, and when gentlemen come to the Committee of the Society of Arts and talk of the superiority of their large screw ships and captains, I deny it entirely. The captains of the small class of merchant ships are quite as clever as they are, and they have just as handy ships. There is no screw steamer in this world that is a handy ship. From their great length they require a lot of time before they can turn out of their course, and they cannot get astern quickly. With regard to steam ships in a fog, I know a very fine steamer belonging to perhaps the grandest company in the world. She was going up the Channel from Plymouth three or four months ago when she was caught in a fog, and they went so slow that the pilot, when the fog had cleared away, was actually two hours out in his calculation of his distance. This shows the extreme difficulty of knowing the exact speed of a steamer, and therefore I am sure there is no man who commands a ship who is worthy of that command who would dare to run the risk in a fog of going anything beyond dead slow in pilot waters. No rule could be more simple than the present law, and if one word could be added to it to make it more effective, I think it would be the word "stop."

Captain P. H. COLOMB: The gallant Admiral's paper appears to be confined to the narrowest possible limits when its title is "Collisions of Steamers in Fogs," but as has been shown by the course of the discussion, the whole question is embraced. It is probably impossible to get beyond the most prominent part of the Admiral's paper without the indulgence of the meeting. I do not know that in the words I have to say I shall get beyond discussing for a few moments the relations of speed to the prevention of collisions between steamers. When we speak of collisions between steamers we ought to recollect that it is *real collisions* we are going to treat of. To prevent accidents which are of daily occurrence, not such collisions as might be cleverly, I admit, imagined with a piece of chalk on a black board. In connection with this inquiry a perfectly impartial person went down to the Admiralty Court and took out 29 collisions that were distinctly and certainly collisions in fogs. The results were printed, and I had the privilege of looking at the paper. Of these there were three in which more than two ships were concerned, but there were 27 out of the 29 cases that were perfectly clear cases such as we might deal with. The data taken out were what are called the preliminary acts; that is a statement made by each ship in a collision case before they can come into Court. It is necessary to be cautious in making those statements because the Court holds each party to its statement. The litigant is thrown out of Court the moment he travels outside the statement made in the preliminary act. In these preliminary acts I have always found two things agreed upon; there is never any question apparently about the respective courses the ships are steering, or as to the nature of the collision. It is pretty evident why that should be so, because, except in the case of sailing vessels, it is very easy to disprove a wrong statement as to course. For a steamer is proceeding from one point to some other point, and there is a certain course due to that voyage, and she takes it. The nature of the blow is seen by both ships, and very commonly one of the ships can be examined; and, therefore, you may depend upon these two facts. Having started with the courses and the nature of the blow, you can generally pretty well sift the rest of the evidence, even of these preliminary acts, and see what other statements coincide with them. If I refer you for a moment to that little diagram, you see two ships "X" and "Y" whose courses are crossing. If those courses are stated in these preliminary acts, and if "X" states that she sees "Y" on her starboard bow and starboards, and then the following statement is that she is struck by "Y" on her port beam, one can see at once that there is a flaw in her statement, and you can reject it accordingly, so that although you only get in the preliminary acts the original statement, yet for all the purposes of this discussion they may be accepted as facts. That being so, we might safely consider these 27 cases that are spoken about. They are all embodied in that one diagram, and

then we come to what effect had speed on these 27 collisions. First of all, 9 of the ships tell us that they were not exceeding 8 knots; 6 of them say they were

not exceeding 6 knots; 26 say they were not exceeding 4 knots; and 13 they were going dead slow, not exceeding 2 knots. Of course subsequent investigation might modify those statements. Probably, if one looked into the evidence given before the Court afterwards, we should find that these were not accurate all through, but still so many of the collisions happened in places where a ship would not naturally be going fast that we may suppose the statements are not very far out. Therefore on the face of it we find that speed is not really concerned in these cases of collision. And all my investigations cause me to coincide with that view that, as a rule, the speed of the ship does not affect the collision, that is to say, that you cannot take any number of collisions out and say, "that was because they were going too fast," "that was because they were not going slow enough"—you cannot say distinctly that speed is a cause of the collision. There are two ways of course of looking at reduced speed; you have to look at it as lessening the danger of collision; or to help you to avoid the collision. In these 27 cases the damage is not stated, but I am able to say from all the investigations I have made, that the damage does not follow speed, it does not increase as speed rises. The damage follows the nature of the blow, not the speed. A bow to bow, or stem to stem collision—and there are instances of many—never seems to be a very dangerous collision. What is dangerous is when the stem of one ship strikes the beam of the other. Sir Frederick Bramwell, when I was speaking of this before him, pointed out to me and to the Committee of the Society of Arts, a matter which I spoke of the other day in this Institution, and spoke of very clumsily, and I am not at all sure that I rightly understand it now; but he said this, that practically, when two ships are meeting stem on, you must suppose that they are offering pretty nearly equal resistance, and if you suppose they are going at the same speeds the damage will probably be divided between the two ships, and therefore that there will not be a serious damage to one. It is as if there was an iron wall between them—that was the expression Sir Frederick used. When you come to the stem striking on the side, the stem is very much more capable of resisting a blow than the side, and the damage is commonly all on the side of one ship; it very often sinks one, and a great deal too often sinks both. The Admiral has pointed this out on the paper as one of the reasons why great speed should not be altogether condemned. And you cannot say, on a review of these cases, that the speed itself makes the damage. The nature of the blow is the important point, and if you can avoid striking another ship about her midships with your stem you run a great chance of avoiding the disastrous part of the collision. Dismissing this part, you come to think about the use of speed for avoiding collision because if reduced speed will enable you to avoid collision you should use your reduced speed and stick to it. There is a general objection to high speed. In the first place, there is greater momentum, and therefore you are less capable of controlling it. There must also be a less reserve in case you want to get a back turn, that is to say, you have all that momentum to overcome before you can get your steam to take the way off the ship. There is also a possible increase of space required for the ship in turning. The greater momentum requires a greater power to overcome it, and therefore you lose so much control by keeping your ship at speed. On those grounds a full head of steam and low speed would naturally enable you to stop your ship in

the shortest time, and in the smallest possible space. But with low speed by itself, if you had low steam at the same time, your want of control of the momentum would be proportionate. So far you might say that moderate speed, with a reserve of steam always, would be imperative. But then there is this to be said, that low speed under the law is not always safe, and that is the most difficult hitch I think in the whole matter. If you look at "X" and "Y" you see that "Y" is nearer to the crossing point than "X." If "Y" has the right under the law—as she undoubtedly has—to cross the path of "X" the higher her speed to do it the greater the safety; on the other hand, if "X" is bound to let "Y" cross her path, the less speed "X" has the better. So that what you really want, if you could have such a thing with the law as it stands at present, is that the giving-way ship should have to reduce her speed while the law should urge the holding-on ship—the crossing ship—to give her utmost speed so as to cross the path of the other as soon as possible. The laws applying to those ships are that both are to be at "moderate speed," supposing them to be in a fog, and that both are to slacken speed. But, as I said, if "Y" has a right to cross then that law is not a good thing for her, because "Y" ought to have the right to use her utmost speed; and in point of fact you will constantly find, in spite of the wording of the law, "Y" is either commended in the Admiralty Court, or not blamed, or sometimes encouraged, for going at her utmost speed when she had the right to cross the path of the other. But then I think low speed has a great advantage of its own, it gives you time to think, which is a very important matter, and on those grounds I uphold "moderate speed" and also "slackening speed;" and on this further ground, because I believe, and hold most distinctly, that the crossing for "X" should not be lawful; that it should not be right for her to make any attempt to cross the path of "Y," and I am quite sure that the old law up to 1866 was perfectly clear on that point; it would have forbidden in the strongest terms all attempts by "X," being the giving-way ship, to try and cross the path of "Y:" and the danger we have in a fog is just that very thing that we do not know—being the holding-on ship—in what way the giving-way ship will treat us. I said it might be that high speed might limit your powers of manœuvring, and make the space which you require to turn in greater than it would be at low speed. Recently many experiments have been carried out in measuring the turning powers of ships. I have not found a single case where an increase of speed of the ship directly influenced the space required to turn it until two or three days ago, and this was in the case of a small steamboat, and there the increase in the space required for turning was most marked. Indirectly there is no doubt speed has more or less effect. Where your power over the tiller is small the travel of the tiller is slow when you are at high speed, and very often you do not get the helm over to the full angle that you would at low speed. That is a very common feature in ships with high speed. Change of trim which is effected when you are going at high speed also appears to have the effect of increasing the space you require to turn in. To turn back to "X" and "Y," if either "X" or "Y" should turn short of the path of the other, of course you are getting rid of some of the danger of collision which exists as long as they are proceeding towards the point where their paths cross. When you have low speed, by reversing and being able to put your helm over to the full angle, you enable yourself to turn short of these paths in cases where you could not do it with the higher speed. But all such action is absolutely fatal to you if you use it to turn across the path of the other; it is only of use to you to reduce your speed when your intention is *not* to cross the path of the other. And I suppose it is sufficiently evident that to delay yourself by reducing your speed at the same time that you are trying to turn across the path of the other is merely to make it more certain that the collision would occur, because when there is to be crossing at all the sooner that crossing can be got over by the one ship the better for the safety of both of them. But the real cause of these collisions is not so much the speed, judging from the collisions which actually occur, as the way you lose your helm. I have just said, for instance, it would be fatal for "Y" to port his helm in that case, and equally fatal for "X" to starboard his, because they are doing exactly the very thing to bring about a collision, specially so when either of the ships is at low speed. In the cases that I am dealing with I find that in 14 of them "X" put

her helm to starboard; in 19 "Y" put her helm to port; in 13 both ships so acted. In 21 out of the 27 cases this wrong helm was present; in only two is it claimed not to be present, and in those cases, by the analysis which I spoke of, you see that the statement is incorrect, that there was in these cases this improper element. Now what ought you to do in the case of "X," supposing, for instance, "X" hears on her starboard bow a fog-signal? Several speakers have spoken of the difficulty of knowing whence the sound is coming. In the records of collision I do not see that present; they all say originally where the sound comes from, and the ship turns up in the direction in which she ought to turn up supposing the sound came from that point. So that however true it may be—and I have found it true myself in cases—it is not a practical fact which covers the risk of collision. According to what I have said, what ought "X" to do on hearing fog-signals from where "Y" is? "X" is, of course, the giving-way ship. We see what happens, that if she starboards her helm she will have a great chance of collision because that is what generally precedes collision. I say that, of course, she is to stop in any case, because "Y" has the right to cross her path, and she should do everything she possibly can to enable her to do so. If she uses helm at all that helm should be port helm, because she ought not to make any helm movement which would tend to take her across the path which the other ship has a right to pursue. With regard to the holding-on ship, of course she has a perfect right under the law to go straight on. She cannot be blamed under the law for going straight on unless a fog is held—as the lecturer has pointed out some people do hold it—to bring a ship under Clause 23, freeing both ships from that law. "Y" is only lawfully enabled to use her helm under that clause, and if she so uses it she ought, in my opinion, to turn towards the other ship; her helm ought to be starboarded. I might say this on no further ground than that wherever you find collision it is the opposite helm which precedes the collision, and not the helm which I recommend.

NOTE.—*Diagrams subsequently drawn at Admiral Ryder's request to illustrate my Views on Avoiding Collision in Fogs.*—P. H. COLOMB.

The positions of the ships in the diagrams are those usual before collision.

The paths marked are those of actual ships which have been accurately measured.

The scale is ¼ in. = 100 feet; but whatever the scale, the facts are the same.

FIG. 1. X is steering north, at any speed. Y is steering S.W., half S. Y is 500 yards, 1½ points, on the starboard bow of X.

X, a steamer, hears a steam whistle 1½ points on starboard bow. She is the giving-way ship. By law she must reduce her speed; she may do whatever she thinks safest with her helm. If she ports (*i.e.*, turns in the direction of the sound) collision becomes impossible, as Y cannot steer outside the shaded part. If she starboards (*i.e.*, turns away from the sound) or continues her course, collision is highly probable, perhaps inevitable, depending on the relative speeds.

The reduction of speed made by X, by law, tends to increase the danger in this latter case. But Y, by law, should keep her course, then X removes the risk altogether by porting, but may make collision inevitable by starboarding.

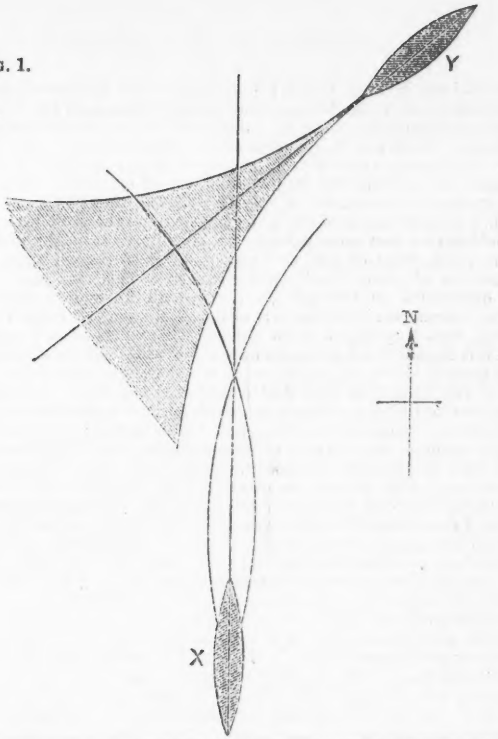
Note.—That Y may think danger "immediate" and *not* keep her course.

FIG. 2. X is steering north, at any speed. Y is steering S.E. at any speed. Y is 140 yards, 2½ points, on the port bow of X.

X, a steamer, hears a steam whistle 2½ points on the port bow, but apparently so close that the danger is "immediate" and that she should take advantage of the Immediate Danger Clause, which absolves her of the obligation to "keep her course," which she otherwise ought to do by law. If X immediately puts her helm hard a-starboard, and Y at the same time (hearing X's steam whistle) puts her helm hard a-port, the ships can clear each other; but if any other movements are made they cannot do so. That is, that in many cases of immediate danger of collision in this form—which is the usual one—mutually turning towards each other may avoid collision otherwise inevitable.

Note.—That in turning towards the sound in a fog you should never turn beyond its estimated direction. If it is estimated two points on the bow, the turn should not be more than two points.

FIG. 1.



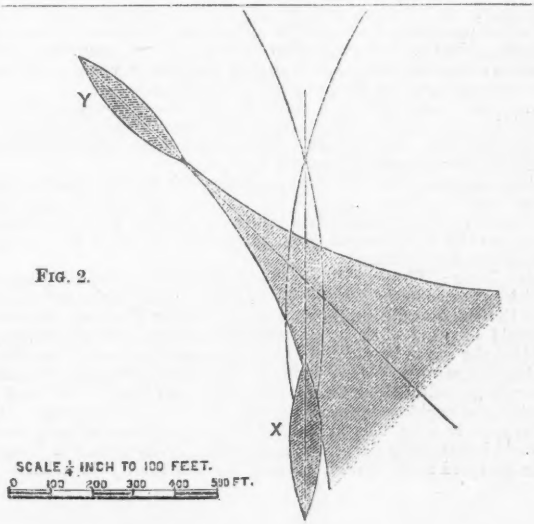


FIG. 2.

Lieut.-Colonel BAYLIS, Q.C.: I hope that I may be allowed, as one who has some experience in trying Admiralty actions at Liverpool, to say that I think that it would not do to define the word "moderate" speed; it must depend upon circumstances. There may be a dense fog; the vessel may be on the high seas, or it may be in a channel where a great number of ships are about; it may be that the fog comes on suddenly, and that the position of other ships just before the fog comes on may be known, and it may be desirable that the speed should be increased. I think that it would be better not to define the word "moderate" speed; we should have a very great difficulty in saying that it ought to be three, four, five, six miles, more or less, as "moderate" must depend upon the ship, the circumstances of place, density and duration of fog, and many other matters to be determined on the emergency. We all know how dangerous changes of widely circulated regulations are, although we may all agree that when rules are really bad, they ought to be altered. But unless there is something really faulty, it is expedient not hastily to alter a law which affects ships in different and distant parts of the world, where many would be ignorant of the alteration. It would be very dangerous, especially in matters of this kind. It is suggested by the gallant Admiral that any infringement of this law as to moderate speed might be more strictly enforced. I do not see how it can be. In cases where no collision has occurred or injury resulted from a breach of this regulation, you could hardly punish the captain for that which has increased the success, and perhaps diminished the perils, of the voyage. The higher rate of speed really may have been beneficial. The word "moderate" is a very elastic term, depending on the circumstances of the case, and I do not consider it desirable to impose further penalties, simply because there has been any excess of speed. Besides, there might be a difficulty, in order to procure a conviction, in ascertaining what has been the exact speed of the ship except perhaps from the log, and the state of the weather, &c. Although we know that logs are very fairly and properly kept as a rule, they are not always so; those who intend to do wrong do not always keep their logs as they ought to do, and they might under the circumstances referred to be tempted to do wrong with regard to entries or omission of entries in the log. I think it would be undesirable that there should be any new mode of punishing a breach of this rule. As it stands, any person who is injured thereby has his remedy by action, and can recover damages in the Civil Courts, and the statute 25 and 26 Vict., c. 63, s. 27, enacts that owners and masters of ships in case of *wilful default*, for each occasion when the regulations are infringed, shall be guilty of a *misdemeanour*, besides being liable to a criminal proceeding for loss of life or personal injury for culpable negligence. I think things had better stand as they are unless it is the opinion of those who are much more competent than I am to express an opinion upon it, and they should clearly define in what way the law should be changed.

Admiral Sir E. OMMANNEY: I should like to ask one question. Captain Colomb has been kind enough to investigate a great number of cases of collision: it would be interesting to the meeting to know if he considers those collisions preventible had they followed the ordinary rules of the road.

Captain COLOMB: It is difficult to say, because it depends whether they were so close as to make all movement futile; but going upon the fact that we know the opposite movements are constantly made, yet they never precede collisions. I can only suppose that in these cases, if the proper movement had been made, the collision would not have occurred.

Captain LONG: Whenever I have considered this question, it has appeared to me that with reference to the law which says that when two ships are crossing so as to involve the risk of collision, the ship which has the other on her own starboard side should keep out of the way of that other, it would be an advantage if it also stated that she was to keep out of the way by passing astern of the other.

Captain JOHNSTONE: With regard to the diagram which Captain Colomb has drawn on the wall (p. 762), I think I understood him to say that if "Y" had to alter her helm at all, she ought to starboard, and "X" if she altered her helm at all ought to put it to port. In a fog, when the position of the two ships is unknown, it seems to me that would be extremely dangerous, and further, if the vessel "Y" were at liberty to alter her speed as she turned, you could not tell exactly the relative position of

those two ships, and if she were lower down, by increasing her speed she might just go into "X" instead of passing astern of her. I think that alteration of speed of that kind in a fog might be rather dangerous, that is to say, one vessel increasing her speed very much. It is generally assumed that no accident has ever occurred from a vessel going at speed in the ocean, but it is very well known that an immense number of vessels—it is an immense number considering the amount of property and life that is lost—are never heard of, and no one knows how many of these losses are due to collision. Occasionally public attention is directed to the matter, and it is put down to some other cause; but it always seems to me that collision at sea may have a great deal to answer for. One case that some years ago excited great attention at the time was the "City of Boston." She was a first class ship: she went to sea and was never heard of again. There is another ship, the loss of which it has always seemed to me might probably have been due to the same cause, the "Atalanta." I do not think Officers of the Navy generally believe that the "Atalanta" capsized; I certainly never did. I think her loss was probably due to collision or fire. Probably a great many losses in the Atlantic are due to that cause, and I think the Legislature ought to be rather careful about giving vessels permission to travel at unlimited speeds in the open ocean. The result of the present regulations is, that captains of merchant ships do take very great care. Coming up Channel I found the captain of a P. and O. vessel exercised very great care indeed. Everybody was very anxious to arrive at London on a particular day, but after anchoring in Plymouth Sound a fog came on, not a thick fog, and he would not move. He went out in the Channel, got some distance off the coast, and would not go on any further, but anchored again. The vessel was delayed twenty-four hours, when I should have thought she might have gone on. That shows that very great care is taken in the matter.

The CHAIRMAN: At this late hour I shall not detain you long. Stress is laid on 4 knots being the speed for our men-of-war squadrons. They have no object in going at higher speed, but when there is an object we are no better than our brethren of the merchant service. Captain Vansittart, in the "Arizona" was once ordered to be off Dover by a certain time, necessitating 12 knots speed, which he carried out in a dense fog. I was four years in Newfoundland, and never slackened speed on account of fog alone, trusting to look-out and the fact that an iceberg is easier seen in a fog than land; but my full speed was only 8 knots—moderate speed of the present day. I may say I fully hold with the captains of Atlantic steamers going 15 or 17 knots in fog in the open sea only slackening when they come into narrow waters. In making the land or lights at night, it is the proper system to go ahead at full speed as long as you possibly can, and then to stop and keep your land or light in sight. Of course the captain of an ocean steamer is obliged to go on: I should like to see the captain of a Cunard or an Inman steamer stop with 300 passengers, all growling at him, as well as 1,000 emigrants. But when they come within narrow waters, then they would be brought to book if speed is not reduced. Of course it is the owners who in these matters are really to blame, for the captain only carries out their intentions and not their instructions. In narrow waters I would fix a maximum for moderate speed, and that should be 6 knots, because there is no ship that can possibly be said *not* to be under control at 6 knots. There are some who say they cannot reduce the speed to that point, but I would make that the maximum, and not allow it to be exceeded. I concur in the remark that what was "moderate" speed a few years ago is now only ordinary speed.

Lieut.-Colonel BAYLIS: The Courts only recently gave a decision upon the word "moderate," and the outcome of it is, that it depends upon circumstances.

The CHAIRMAN: I think the "City of Boston" alluded to by Captain Johnstone was probably lost by collision with an iceberg in the night, and not with a ship. Had such been the case, two losses would have been reported.[1] An iceberg in

[1] I had intended confirming the author's remark as to the best position for a look-out in a fog being as close to the water as possible. In 1870 Commodore Willis took the Reserve Squadron up Bantry Bay in a thick fog—there were look-out

"open sea" is only in comparison as a dot on a large sheet of paper, and the risk of collision is so minute it is not worth considering, and if a collision occurs, as in the case of the "Arizona," the damage, in my opinion, would have been greater at a moderate speed than at full speed—the element of time must be considered.[1]

Admiral RYDER, in reply, said: The first question asked was why the replies of the various Captains who sent in answers were not given. I explained in the paper that they were invited to write on the express understanding that their names would not be given. You may naturally say, "If you did not give the names, you might still have given the replies." The Society of Arts thought it well in issuing the *preliminary* Report to print nothing more. They thought well until they saw whether any action was going to be taken to retain their evidence. The Fog Collision Committee throw themselves on your forbearance, and ask you to believe that the right persons were invited to reply, and that a large majority gave the evidence which they are said to have given, and you must be so good as to trust the Committee in this matter. Captain Lindsay Brine stated that he preferred the *status quo*. He and I have talked the matter over before, and I know he is very firm in that opinion, and that he would not alter the law, but would accept the fact that a number of seamen in positions of fearful responsibility are breaking the law frequently, almost every voyage, but it matters nothing to him. He would not keep them out of that difficulty by altering the law, neither would he punish them for what they are doing against the law. Well, it is a difficult question. My own feeling is, that this present practice is very demoralizing. The passengers on board a steamer have an immense respect for that middle-aged gentleman on the bridge, but they must know he is breaking the law in every fog they encounter, I say. But if he breaks the law in one way, why not in another? It is bad for anyone; it is bad for any of you or me if we break a moral law or any law constantly; it is most demoralizing, and I protest against its continuance. There ought to be some remedy for it. The remedy which the Committee of the Society of Arts throw out (but only for consideration), may not be the best, but the *status quo* I maintain is not and cannot be right. I did not quite gather from Mr. Liggins's statement whether he would like the law altered or not. Talking about "taking the way off her," we had very first rate evidence from Sir Digby Murray, a seaman of great experience and reputation, a permanent official of the Board of Trade. His practice was, he said, "the moment he heard a fog-signal anywhere, except perhaps right astern, to 'take the way off her'"—those were his words—viz., to reduce speed immediately, and that no doubt is a very seamanlike view of the question at that stage, but up to the instant of hearing the fog-signal he had been breaking the law. Captain Johnstone says, and rightly, that we must not conclude because we do not hear of these fatal collisions in the open ocean, that there are none. Day by day we hear of missing steamers. What a number of steamers are written off yearly—they are written off day by day at Lloyd's. Many fine vessels thus pass off the lists, and what has become of them? It is not unnatural to assume that some of them may have been in collision in couples at sea, and both ships have vanished. If we could see through the veil of deep water between us and them, we should, I have no doubt, often see two vessels lying side by side in a great many of these cases at the bottom of the ocean. I did not quite make out whether Colonel Baylis is satisfied with the law. I quite agree with him that it is very

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men from the mast-head down to lowest gangway steps—the latter was the first man to see, not the land, but the surf on the shore—white is always seen through a fog better than black. I once passed the Fastnet in a fog—the breakers and the white lighthouse were seen, but not the black rock between them. These are facts well known to Newfoundlanders, who coast by what they call the "land routh," *i.e.*, surf—do not see the land, as I have often done where the coast was steep too.

[1] By this I mean at the high speed the danger done was localized, being effected so rapidly, whereas at reduced speed it would have been distributed, on the principle of penetration *versus* racking in artillery fire, or the tallow candle which at a high velocity goes through a deal board, against which it would have been smashed if thrown by hand.

difficult to define the word "moderate," but he did not say quite clearly whether or not he would wish to see anything like the alteration suggested above for consideration or anything else, or whether he would leave matters just as they are. I thought he rather steered round the question, but I may be wrong in that. There is only one thing more to which I may allude, and that is this. We talk of two vessels giving blows end on to one another, and blows at right angles to one another. My firm belief is, that a collier under sail, if she weighed from 800 to 1,000 tons, striking at 8 knots full on the beam of any ironclad we have got, they would both go to the bottom. I do not think the ironclad could so arrest the motion of 800 to 1,000 tons without being so penetrated by the blow that she would be bound to go to the bottom. The experiment might be worth trying in shallow water, say a foot or two more than the ironclad's draught.

Mr. LIGGINS: I should say from the moral point of view I should certainly like the law to be a little altered, but from a seaman's point of view I think it would be desirable to let it remain as it is.

The CHAIRMAN: I am sure you will all agree with me that we owe our thanks to Admiral Ryder for his lecture, and I am sure we have gained considerable information from the admirable discussion that has followed it.

NOTE.—Lieut.-Colonel Baylis, Q.C., has since sent the following note, thinking it may be useful, as defining in several recent cases what the Courts have decided to be "moderate speed":—

What is "a moderate speed" for a sailing ship in a fog was recently held by the Court of Appeal to depend on the place where the ship happens to be (and *semble* per Cotton, L.J., her handiness, and is not necessarily proportioned to or less than the maximum speed she can make under the circumstances). A speed of about 5 knots in the case of a sailing ship out in the Atlantic Ocean is "a moderate speed," and in compliance with this rule, she being at the time under all plain sail, and going as fast as she can with the wind on her quarter. The "Elysia," 46 L. T. 840, 4 Asp. M. C. 540 C.A.

It was also held to be the duty of those who have the charge of a steamship in motion during a dense fog, on first hearing the whistle of another steamship in close proximity to them, that risk of collision between the two vessels is involved, to bring their vessel immediately to a standstill on the water, and not execute any manœuvre with their helm until they have definitely ascertained the position and course of the other ship ("The Kirby Hall," 8 P.D. 71), and that in a dense fog it is the duty of a steamship to anchor as soon as circumstances permit. "The Otter," 4 L. R. Adm. 203.

The House of Lords held it to be the duty of a vessel when in the *vicinity* of a fog-bank to make the signals required by Art. 10 (now 12) to warn vessels within it of her presence. "The Milanese," 45 L. T. 151, 4 Asp. M. C. 438, App. C.A.

The Regulations must be strictly followed—actual necessity only excuses a departure, "Stoomvart *v.* P. & O. Steamship Company, 5 App. Cas. 876 H.L. (E.)

N.B.—Since this meeting was held three important decisions of the Court of Appeal have been reported:—(1.) The "Beta," 9 P.D. 134, where it was held that the sailing vessel "Beta" was alone to blame in a collision with the steamer "Peter Graham" in the Bristol Channel, for going in a dense fog at a speed greater than was necessary to keep her under reasonable control. That the word "moderate," in Article 13, is a relative term: it depends on place, on the kind of ship, and on the kind of fog. (2.) The "John McIntyre," 9 P.D. 137. A steamer heard a whistle on her port bow in a dense fog, and it was repeated, showing that the vessel from which it was sounded was approaching and was in her vicinity. Held that under the circumstances it is a general rule of conduct that there is a necessity to stop and reverse under Article 18, and that both steamers were to blame. The Master of the Rolls then said:—"It may be laid down as a general rule of conduct that it is necessary to stop and reverse, not indeed every time that a steamer hears a whistle or fog-horn in a dense fog, but when in such a fog it is heard on either bow and approaching, and is in the vicinity, because there must then be a risk of collision." (3.) It was also held in "The Beryl," 9 P.D. 137, that the word "course," in Article 22, refers to the direction of the vessel's head, and not to her speed.—T. H. B.

PROPOSED RHYTHMICAL HINTS FOR PREVENTING COLLISIONS OF STEAMERS IN FOGS.

By Captain X. Y. Z., R.N.

Illustrating the views advocated by Captain P. Colomb, R.N.

N.B.—These are strictly in accordance with the International Regulations, but *not with the almost universal practice* of our Merchant Captains.

From the sound of a fog-signal *don't turn away.*
If you hear it ahead of you there let it stay.
If the sound of it tell you that you should keep clear[1]
Your helm should be moved, so that *towards it you steer.*
But to one great maxim give vigilant heed
You can never be wrong in reducing your speed.

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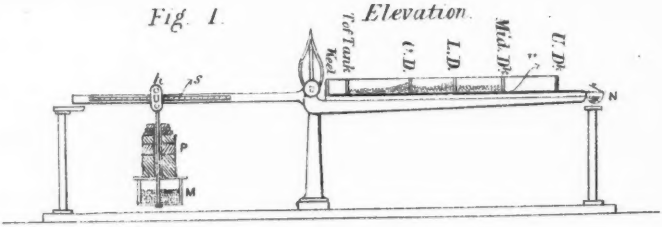
[1] It is the duty of all steamers to keep clear of and give way to steamers on their starboard side. See Art. 16, Regulations for Preventing Collisions at Sea.

A. P. R.

BENJAMIN'S PATENT STABILITY APPARATUS.

Fig. 1. Elevation.



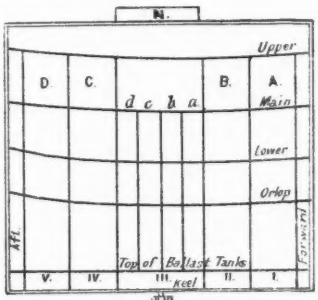


Fig. 2. Plan.

Fig. 3.

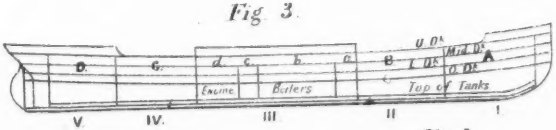


Fig. 4

Fig. 5.

Harrison & Sons Lith. 59 Martins Lane W.C.

DESCRIPTION OF A NEW STABILITY-APPARATUS.

By Ludwig Benjamin, Member of the Institution of Naval Architects.[1]

The object of the apparatus is to find the height of the centre of gravity of a vessel under any load, and thus to indicate whether a vessel in any condition will have that amount of stability for which it has been designed. It consists of a beam-balance, shown in Figs. 1 and 2 (Plate XXVI), on one side of which a drawing r of the ship is fastened, which is especially prepared in the manner to be described later on. Over this drawing partitions are formed by means of little boards, as shown in Fig. 4. These partitions correspond with the various compartments of the ship; and in the same manner as the ship's holds are filled with dead weight, these partitions are filled with a corresponding amount of shot, and represent thus the loaded vessel.

On the other lever of the balance there is a scale s indicating heights above the top of the keel, and along it slides a hanger h, which is so loaded as to represent the total weight of the vessel. When this hanger is moved to that point on which it brings the balance into equilibrium, its position on the scale indicates the height of the centre of gravity above the top of keel.

Any naval architect can easily furnish for every vessel that height to which the centre of gravity can be raised, without endangering the safety of the vessel, for any given draught;[2] while another limit of the centre of gravity is experienced, below which it would make the vessel too stiff. It is easy, then, to see, by means of this apparatus, whether, for any intended load, the centre of gravity will be within these limits, or, if it be found to be not so, to study what changes will be necessary.

[1] Read at the meeting on Wednesday, June 18th, Admiral Sir Frederick W. E. Nicolson, Bart., in the Chair.

[2] This information may be given either by a curve, or more handily by a displacement scale arranged in the following manner:—

Displacement.	Draught.	Dead weight.	Safe height of C. G.
tons.	feet.	tons.	ft. in.
6,000	22	3,500	17 2
5,500	21	3,000	16 10
5,000	20	2,500	16 8
4,500	19	2,000	16 9
4,000	18	1,500	17 0
	17		

Let us assume that the apparatus be applied to a three-decked merchant steamer as shown in Fig. 3. The drawing shown in Fig. 2 is prepared from Fig. 3 in contracted scale. As, for our purpose, the lengths of the different holds are of no moment, the bulkheads on this drawing are put down in given distances to suit the little boards forming the partitions, but the heights of the decks are drawn to scale. To explain this drawing better, the holds in Figs. 2 and 3 are marked by corresponding letters. The drawing is shown in Fig. 1 by the heavy line marked *r*, and is simply pinned to the board of the instrument, with the keel towards the point of suspension of the latter; a line for the keel is given on the board, and corresponds with the zero-point of the scale on the other lever. Over the bulkheads and decks of the drawing, the boards, Fig. 4, are then pinned, thus forming the partitions above mentioned.

Next the apparatus is to be adjusted for the light vessel. The weight of the light vessel and the position of its centre of gravity are data which need to be known, and which can be easily obtained from a naval architect or by a simple inclining experiment.

The sliding hanger of the instrument contains a box M, which is to be filled with shot, to make it correspond with the light weight of the vessel; then this hanger is placed on that point of the scale which is the given height of the centre of gravity of the light vessel; and now the box N on the other side of the apparatus is filled with as much shot as is required to bring the balance into equilibrium. The instrument is now in working order, and it will be noticed that the same instrument can be used for all vessels by adjusting it in the manner described.

Let us now suppose the vessel to be loaded up to the main deck with an homogeneous cargo. The capacities of the different holds are known, and the weight of the cargo for each hold is therefore known too. A corresponding amount of shot is now put into each partition, formed over the drawing of the apparatus, and likewise the partitions representing the bunkers are filled with shot corresponding to the weight of coal put into the ship. A weight equal to the total amount put into the various partitions is then placed on the hanger by means of solid blocks of lead P, properly arranged and marked, and which for simplicity are also used for the weighing of the shot.[1]

The hanger is then removed to that place where it brings the instrument into equilibrium, and indicates on the scale the height of the centre of gravity. Suppose it be found that the latter is within the given limits. It is next to be investigated whether the ship will still remain safe when the bunkers are emptied. For this purpose, it is only necessary to take the shot out of the bunker partitions, to remove the same weight from the hanger, and to bring the balance again into equilibrium. Let the scale indicate now that the centre of gravity is too high, and therefore the ballast-tanks need to be filled. The amount of shot corresponding with the weight of the water-ballast is put into the ballast-tank partitions, the same weight is

[1] The weights are made so that one ounce represents 100 tons in the ship, which, without being unhandy, allows still a great amount of accuracy.

added to the hanger, and the new position of the centre of gravity is found by balancing the apparatus.

Let us now suppose that the vessel discharges in an outport the holds marked B, and fills them with a mixed cargo; say, the lower hold is filled up to 7 feet above the top of the keel by iron rails, and thence upwards to the main deck, light machinery is taken in. At a line 7 feet above the top of the keel one of the boards shown in Fig. 4 is placed, and the partitions are now filled with shot according to the weight of the loads mentioned; the additional weight is placed on the hanger, and the new centre of gravity is found. If the result should show that the ballast-tanks need to be emptied, this operation can be easily performed on the instrument in the same manner as explained.

Let us assume that, besides the load mentioned, some boilers are ready for shipment which can only be taken as deck-load. By placing a little box filled with shot (Fig. 5) on the proper place of the drawing, and adjusting the apparatus for it, it can be easily seen whether this deck-load would endanger the vessel or not.

From the foregoing, it will be evident that by means of this apparatus the loading of the vessel in all phases can be exactly studied. Imitating the real vessel, it shows in a very clear manner results which otherwise could only be obtained by laborious calculations, which do not come into the resources of those who navigate vessels. The apparatus will therefore be of great assistance to captains, superintendents, shipowners, &c. It will be of use, also, for ships of the Royal Navy, where it enables the Captains to study the effect of proposed alterations in armament, stores, &c. In merchant-vessels it will make the owners and captains more independent of the stevedore than they are at present, and they can at any time readily make sure whether their ships are safe, as far as stability is concerned.

The details of the model I have had the honour to lay before you are at present being reconstructed; and the new apparatus, which is manufactured by Messrs. Elliot Brothers, will in all details be as handy and suitable as possible.

If required, it can be made to be used at sea, or to indicate also the trim of the vessel, by extending the principle explained above.

NAMES OF MEMBERS who joined the Institution between the 1st July and 30th September, 1884.

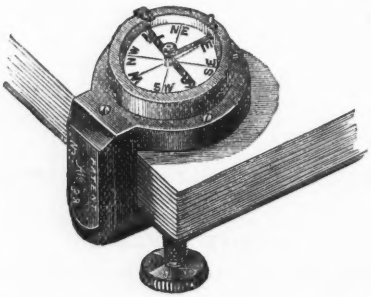
LIFE MEMBERS.

Musgrave, H. E., Capt. 3rd Lanc. Arty. Vols.
Simmons, G. F. H. Le B., Lieut. R.E.
Baynes, H. C. A., Lieut. R.N.
Bridgford, S. T., Major late R.M.A.
Fergusson, C., Lieut. Gren. Gds.
Baylay, F., Lieut. R.E.
Garnons-Williams, R. D., Lieut. Royal Fus.
Theobald, C. B., Capt. R.N.
Ross, T. C., Lieut. High. L.I.
Costobadie, H. H., Major R.A.
Heber-Percy, R. J., Capt. Rif. Bde.

ANNUAL SUBSCRIBERS.

Barlow, M. J., Capt. R.A.
Eckersley, H. F., Lieut. 3rd Bn. S. Lan. Regt.
McMahon, A. H., Lieut. Gren. Gds.
Crompton-Roberts, H. R., Lieut. Gren. Gds.
Vernon-Wentworth, B. C., Lieut. Gren. Gds.
Brooks, L. A., Lieut. 7th Drag. Gds.
Rowe, T., Major Sydney Engineers.
Pilkington, H. L., 21st Hus.
Gwyn, A., Capt. Ind. Marine Service.
Comyn, F. F., Major 4th Bom. Rif.
Pratt, W. R., Capt. Bangalore R. Vols.
Coxhead, J. A., Capt. R.A.
O'Leary, W. E., Lieut. Rl. I. Rif.
Hallum, O. C., Lieut. Rl. I. Rif.
Fox-Strangways, T. S., Lieut. Rl. I. Rif.
Cowley, J. W., Lieut. Ben. S.C.
Vaughan, T. T., Capt. R.A.
Shaw-Hellier, T. B., Lt.-Col. 4th Drag. Gds.
Glentworth, Viscount, Lieut. 5th Bn. Mun. Fus.
Makant, W., Lieut. 3rd Bn. L'pool. Regt.
Petrie, R. D., Lieut. R.E.
Marshall, W. G. H., Lieut. Gren. Gds.
Geach, G. B., Lieut. 4th Drag. Gds.

MAJOR WILKINSON'S (SOUTH LANCASHIRE REGIMENT) "ATTACHMENT COMPASS."



THIS instrument is intended to simplify the performance of rough sketches on active service, where a high degree of accuracy is not required.

It is fitted with Colonel Richards' "Working Meridian," a line engraved on the glass, with which the needle must coincide when in use; its north end directed to the index or projection at one end of the line.

The compass-box can be turned round, so that the "Working Meridian" may be placed in such a relation to the sketch-sheet that the ground to be represented may occupy its centre. When this is done, then, in order to draw the direction of a road or any object:—

1. Face the object exactly.
2. Turn the sketch-sheet, to which the compass is now attached, until the "Working Meridian" corresponds with the needle, which must be level enough to play freely. This "sets" the sketch-sheet in a position corresponding with the ground.
3. Take a flat ruler, or straight edge (on which should be marked the scale you are using), and lay it with its edge corresponding with the point on the sketch from which the line is to be drawn; the edge being at the same time directed on the distant point towards which you are traversing—now draw a line along the edge of the ruler, in the direction of the distant point.

Fuller directions for use are given on pages 155, 156, of the "Text-Book of Military Topography," by Colonel Richards, the compass being similar in its use to that of the cavalry sketching-board. The advantage claimed for it is, that the compass-box can be fixed by the clamp to any note-book, sketch-block, plane table, sabretache, map, &c., enabling any rough sketching to be done without a special board, while it is no larger than the pocket-compass which all Officers would carry on service.

The compass can be obtained at the Army and Navy Stores.

OCCASIONAL PAPERS.

This portion of the Number is reserved for Articles, either Original or Compiled, on Professional Subjects connected with Foreign Naval and Military matters; also for Notices of Professional Books, either Foreign or English.

It is requested that communications or books for review may be addressed to Colonel Lonsdale Hale, at the Royal United Service Institution, Whitehall Yard, London, S.W.

THE ORGANIZATION OF THE ELECTRIC TELEGRAPH IN GERMANY FOR WAR PURPOSES.

(From the "Organisation der Elektrischen Telegraphie in Deutschland für die Zwecke des Krieges." By Major-General CHAUVIN, Director-General of Telegraphs. Pamph., pp. 111. Mittler, Berlin, 1884.)

THE NECESSITY OF CONSIDERING THE MILITARY TELEGRAPHS AS BASED ON THE STATE TELEGRAPHS.

A. *Matériel.*

1. *Lines.*

THE stores carried by the Field Telegraph Detachments in the field must always be very limited in amount, from the fact that the transport accompanying these Detachments must be fully able to keep pace with the rate of marching of at least a pontoon train, and be sufficiently small to take its place in the columns of route of an Army on the move.

Now, if we remember that these Detachments are invariably called upon to at once establish telegraphic communication with every move of the Army Corps, their task will be seen to be not always an easy one.

The first thing, then, is to have stores that enable long lines of telegraph to be worked, but which, at the same time, seeing the way in which transport must always be reduced to a *minimum*, are of the lightest description.

The *matériel* used by the German Field Telegraph Detachments in the last war with France was a copper wire 2 mm. in thickness, carried on pine poles 390 mm. in thickness and 3·90 metres long, or with the insulator on the top, 4 metres long, and this is still to a great extent the *matériel* used. But the length of wire set up and worked by the *personnel* of the Field Telegraph Detachments was only about *one-fortieth part* of the length of wire set up and worked by the *personnel* of the State Telegraphs during the war in France for military purposes. Again, the field lines were far inferior in every way to the State Telegraph lines. The slight poles of the former were often blown down, and the single weak copper wire could bear no comparison to the numerous thick iron wires carried on the strong poles of the French State Telegraphs. Again, the wire of the field lines

being so much nearer the ground was far more liable to wilful or accidental damage, and to avoid this as much as possible the poles were necessarily placed very close together. At the same time, when permanent lines *are* blown down by exceptionally violent gales the damage is often very serious.

Undoubtedly the safest kind of line is an underground one. It not only is far safer as regards damage, but it is less influenced by electrical disturbances.

Germany, at present, is the only country that possesses a system of underground as well as "overhead" or "air-line" wires, and should she ever be compelled to act on the defensive at home, she certainly will find her underground system to be of enormous use to her. The original project for this system was proposed as far back as 1867. Of course, the questions of expense and proper insulation were the chief difficulties in the way, but these have been got over, and we know now the effects of the air at high temperatures on gutta-percha, and that an earth cable to be depended on must be deeply buried, and carefully surrounded by an air-tight casing.

The Field Telegraph then is necessarily a temporary arrangement, and the existing lines of the country should invariably be used for military purposes, when this is possible, or else temporary lines of a more solid description set up instead. But in war rapidity is everything, and the advantage of having a large number of trained artificers and telegraphists such as we have in Germany in the *employés* of the State Telegraphs, and who are available in case of war, needs no explanation.

2. *Telegraph Systems.*

Just as the line itself in the State Telegraphs is superior to that in the Field Telegraphs, so the instruments and apparatus used in the former may be generally described as better in quantity and quality. Instruments for field service must, above all things, be simple and strong, easily carried and easily worked, not liable to get out of order, and should be *recording*. Now, as the Field Telegraph should be looked upon as a branch of the State Telegraphs system, it need scarcely be said that the system used in the former should be the one used in the latter, and in this respect the Morse recorder, up to the present day, is undoubtedly the one to be preferred for the field. Still, though this instrument may be the only service one of the Field Telegraphs, many other kinds of instruments may be found in an enemy's country, and we should always be able to turn these to account. For instance, in the war of 1870–71 the Hughes type-printer was found to be a very useful instrument, not only because it could be somewhat more quickly worked than the Morse, and did not require the message to be written, but when using it the wire *could not be tapped* by the enemy.

With all its merits the Morse recorder has a serious defect for military purposes, and that is, if the enemy can manage to tap the wire he can by very simple contrivances either read, hear, or even feel the message, unless of course the latter is in cypher. A cypher then becomes indispensable if there be any possibility of the enemy getting at the wire. With us in the last war recourse was rarely had to a cypher, on account of the time and trouble it entailed. As soon as the lines were established and the Morse instruments were at work, separate wires connected with the Hughes type-printer, and disconnected with the intermediate stations, were at once established. Thus at Lagny and Versailles the Hughes was used to such an extent that at least a third of the telegrams exchanged between Versailles and Berlin were sent by it, and the wires used with the Morse were thus enormously relieved.

The batteries used in the State Telegraphs are unsuited, at any rate in their present form, for field service. A special kind of Marié-Davy

battery was used in the war for this purpose, and gave entire satisfaction. Two other kinds have been designed for field service—one of the firm of Siemens and Halske, and another known as the Barbie ; but these have never stood the practical test of war as has the Marié-Davy. Whenever the latter got out of order in the last war it was invariably the result of carelessness, and there is no reason why it should not be retained in the Service with certain slight modifications, perhaps, such as those proposed by Fischer von Treuenfeld.

At the commencement of the Franco-German War, the State Telegraphs of the North German Confederation had 3,100 Morse instruments and 115 Hughes type-printers and Siemens quick-writers, whereas the Field Telegraphs had 70 Morse instruments only.

In the year 1881 the German State Telegraphs, exclusive of Bavaria and Wurtemberg, had 11,072 instruments, or more than three times as many as ten years previously.

Inventions and improvements are constantly taking place in telegraphy, and although these should be first taken up and tested by the State Telegraphs, the Field Telegraphs should always get the benefit of such innovations, and it is the duty of those concerned to see that they do. Instruments of an inferior pattern can always be exchanged for better ones with the State Telegraphs, where some use can invariably be found for them.

Fortunately for Germany she has in the well-known firm of Siemens and Halske of Berlin every assistance in the way of discoveries and improvements in the science of electricity, and she is thus independent of foreign help.

B. *Personnel.*

1. *Employés of the State Telegraphs.*

The value of a highly-trained and experienced body of telegraphists, artificers, &c., it is unnecessary to say, cannot be over-estimated. Now, there is no doubt the German Army, which must be in a constant state of preparation to take the field, *requires the utmost support from the State Telegraphs, and, what is more, reckons upon it.* And it may well be asked, then, are the State Telegraphs in a position to meet the requirements of our increased Army in telegraph *employés?* Can they, in other words, furnish the Army when it takes the field with the right kind of men in sufficient numbers?[1] The kind of work that sometimes falls to the lot of a telegraph clerk in war is of no ordinary kind. Take, for instance, a man who finds he is suddenly cut off and helpless, with a bundle of the most important messages waiting to be sent, some of which may perhaps decide a general action. Every possible device which he knows, he has tried in vain, and there is nothing for it but to wait for daylight, perhaps, and send for assistance. On such occasions a well-trained and experienced manipulator does not lose his head, but watches his instrument and waits for every possible chance. But, again, it is only from men *trained as soldiers for war*, or having a naturally strong military spirit, that the necessary devotion to duty can be expected. It may sometimes end in certain death or captivity.

Numerous cases of indefatigable devotion to duty, coupled often with great military resource in turning existing arrangements to account, might be quoted from the wars of 1864, 1866, and 1870–71, but to do this is hardly necessary here.

Most of the inspectors and telegraph clerks were, indeed, men who, as non-commissioned officers in the Army, had earned their right to civil employment by the State, and the advantages of this system of being able to secure the services of old non-commissioned officers for telegraph purposes in

[1] Some 50 inspectors and 1,000 telegraphists and linemen.

war, as well as of inducing them to serve on with the colours in peace, are evident both in the interests of the Army generally and the Telegraphs.

In the Franco-German War the State Telegraphs partly set up and partly repaired—in many cases having to erect the poles—some 12,500 kilometres of wire, and, besides this, considerably increased the number of wires in the districts of the "Général Gouvernements," so that all points of military importance in these *rayons* were in telegraphic communication. 118 telegraph stations were, moreover, established by them, and worked day and night.

The total length of wire set up and worked by the Field Telegraphs, that is to say, out of the thin copper wire and slight poles carried by them, was some 1,780 kilometres. The number of telegraph stations set up by them, and worked for longer or shorter periods, was 407. The figures 1,780 include such field lines as were established by the No. 1 sections of the Etappen Telegraph Detachments with their engineers, assisted by the telegraph *employés* attached, as well as the lines that were set up by the Bavarian and Wurtemberg Telegraph Detachments. Had the Telegraph Detachments that were subsequently formed accompanied the army in the field from the first, the field-lines would probably have been a fourth as much again, or some 2,225 kilometres. But these figures do not represent the work done by the Detachments, as field-lines have not only to be set up but taken down again, and as the work entailed is about the same in either case, twice 2,225, or 4,450, kilometres give a better idea of the work done.

Section No. 2 of the Etappen Telegraph Detachments converted 8,252 kilometres of French wires into military purposes, and set up 798 kilometres of temporary wires. Adding the 12,500 kilometres already alluded to we get 4,450 and 21,550 kilometres, as showing the work done by the engineers and State Telegraphs respectively, or in the proportion of 1 to 5, neglecting the assistance given by the *employés* of Section No. 1 to the engineers.

These numbers must not, of course, be taken to show accurately the work done, but they certainly are sufficient to show the utter impossibility of a *purely military* organization for our Telegraphs for war purposes.

It being then a recognized fact that we must depend in war to a very great extent on the State Telegraphs, there only remains perhaps the question whether the Telegraph Detachments could not with the Etappen Telegraph Detachments meet purely military requirements, and thus reduce the work expected of the State Telegraphs to a *minimum*. The work done by the State Telegraphs was in the last war so severe that only men of long training and experience could have been expected to have done it with the necessary rapidity. To ask the Field Telegraphs to undertake it in addition to the work already expected of them, would be quite out of the question.

The experiences of the Franco-German War have distinctly shown the necessity of a Telegraph Corps, but the question of expense limits its size to what is only necessary, that is to say, it must only be sufficiently large to enable to be trained in peace the Officers and men required for the Field Telegraph and Etappen Telegraph Detachments in war.

From what has been said it stands to reason that a Telegraph Detachment should be under a man who combines with the knowledge of war the technical knowledge which is indispensable to enable him to test and appreciate such inventions and improvements as are constantly taking place, and turn them to account for military purposes, and certainly no man would appear to be better fitted for such a post than a Field Officer of Engineers who had served on the General Staff.

The State Telegraphs must then at all times be ready to follow the Army in the field and be at its service with its *matériel* and *personnel*.

There were in the German State Telegraphs before the Franco-German War a considerable number of ex-Officers and non-commissioned officers of

all branches of the Service. Of the latter many whilst in the Service and when stationed in fortresses and State Telegraph stations had learnt to use the Morse alphabet; these, on completing the service entitling them to civil employment by the State, went through a course in the telegraph schools, and on passing the required examination were appointed as telegraph clerks. These were the men chiefly selected for service with the Army in the field. For the work of actually setting up lines belonging to the State Telegraphs, as well as of restoring such lines in the enemy's country as could be properly considered as forming an extension of the State Telegraphs, a certain number of artificers and linemen employed by the State Telegraphs in place were attached to the Etappen Telegraph Detachments.

2. *The Engineers.*

The Etappen Telegraphs only reached to what may be called the tactical sphere of the Army in the field, beyond this the work fell to the Field Telegraphs. These had to be prepared to act as a combatant branch of the Service, and work with activity and enterprise in spite of a hostile population and the occasional obstructiveness of the troops of the Army to which it belonged. And to no small extent was the success that generally crowned its efforts due to their good feeling and spirit in this respect.

Following the advanced guard on foot, they had to set up and take down their lines, thus working sometimes in front and sometimes behind the main body. To do this the engineers were undoubtedly the best kind of men to employ, and their Officers were certainly the best able to take charge of the Field Telegraph Detachments.

Engineer Officers had moreover gone through a course of military telegraphy in peace-time at the Artillery and Engineer School, and a certain number of tolerably senior Officers had been theoretically trained under the directions of the Inspector-General of Telegraphs in the various duties connected with the command of Field Telegraph Detachments. They had had some practical exercises by the Engineer Battalion of the Guard in setting up lines, establishing stations, &c., and finally exercises of what were likely to be required in war that were carried out annually at the great manœuvres.

The men of the engineers had learnt the manipulation of the instruments as well as it was possible during the short period of the exercises, and as many non-commissioned officers as possible had been trained in the Morse system. But all this was not sufficient to enable the engineers to work with certainty and regularity in the field, and it was found necessary on mobilization to attach a certain number of experienced telegraphists.

Organization of the State and Military Telegraphs.

The German telegraphs may be said on the whole to have worked very well in the last war, and it only remains to see how far the experience gained should be turned to account so that in the next war it may do even better. Taking them then as divided into—

A. *The State Telegraphs;*
B. *The Etappen Telegraph Detachments;*
C. *The Field Telegraph Detachments;*

there arises first the question how can the general efficiency of the whole system be improved? And there seems to be no doubt both from our own experiences as well as from the experiences of others in war that the main point is to improve and increase what may be called the use of the telegraph for *tactical purposes.*

It was recognized before the last war that the telegraph could be used on

the battle-field itself, and had a sufficient number of Field and Etappen Telegraph Detachments been previously trained in peace and accompanied the army in the field at the outset, such undoubtedly would have proved to have been perfectly possible. In the great battles, such as Wörth, Gravelotte, and Sedan, which did not come about unexpectedly, there would have been plenty of time to have done so; it would have been quite possible to have established telegraphic communication between the Commander-in-Chief of the Army and his subordinate Generals on the field of battle.

At the Battle of Wörth on the 6th August it would have been quite feasible, with two Field Telegraph Detachments sent on the 5th to Preuschdorf, to have connected that place on the one side with Gunsttett by Dieffenbach, and on the other with Langensulzbach by Görsdorf, by the time the Crown Prince appeared on the scene, and afterwards to have produced the latter line to Albrechtshäuserhof as soon as the 11th Corps had entered the Niederwald. An office-wagon stationed on the heights between Wörth and Dieffenbach—the position of the Crown Prince during the battle—could easily have been connected with Dieffenbach. The Etappen Telegraph Detachment would have had no difficulty in connecting Preuschdorf with Sulz on the 5th before dark.

At the Battle of Gravelotte a double line might have been set up from Flavigny—the first position of the King's headquarters—to Rezonville, and from that place another to Verneville and Gravelotte, and four stations established at these places. Had two Field Detachments commenced this in the early morning they could have accomplished the work by midday.

At the Battle of Sedan two Detachments could perfectly well have connected the King's headquarters on the heights behind Frenois in time, that is to say, by 10 or 11 in the forenoon on the 2nd September, with St. Menges on the one side and Remilly on the other. Similarly the Field Telegraph Detachment of the Army of the Meuse could have connected Remilly with the headquarters at Mairy.

The mobility of our Field Telegraph Detachments enabled them indeed to set up a wire, and keep pace with the advanced guards, to which indeed they were attached, and even on certain occasions to keep pace with the heads of the advanced guards. Under such circumstances it sometimes happened that the telegraph stations came under fire, or had to retire before the enemy. But though there is no doubt about our Field Telegraph Detachments having been able in their present formation to work in the foremost line, and send information of the doings of the enemy to the Officers commanding outposts, and consequently may be expected to do much more in their new formation, which will be dealt with presently, still it will not always be safe to rely and trust solely to them in spite of their performances in this respect, as well as the brilliant examples set by the North American telegraphs in the Civil War of 1861–66.

Fischer v. Treuenfeld, in his book "Military Telegraphy," tell us that the Federals not only used the telegraph to communicate between headquarters and the subordinate commanders in the Battle of Fredericksburg, Chancellorsville, and the blockade of Atlanta, but actually pushed telegraph offices with their signal corps into the fighting line. Similarly in the war in Paraguay (1864–69) the telegraph was used on the field of battle in a way that had never been seen before.

But before going any further into the question, it is well to ask whether *visual telegraphy*, that is to say, *signalling*, should be given a place in our organization.

And we should say "yes" if it appeared to be a desirable adjunct to the electric telegraph, or were of so great a use in the handling of troops as to more than compensate for the disadvantage of there being no proofs or documents of messages sent.

But neither of these arguments holds good. In the North American War signalling did very good service, but then the circumstances were peculiar.

In the first place at the commencement of the war the signalling corps was the only means the Army had of sending messages, as neither State, civil, nor military telegraphs existed. The signalling corps was used in peace for surveying and watching the Indian frontier, and was provided with a small amount of telegraph stores in addition to their signalling apparatus. It had a great deal of practice in signalling but very little in telegraphy, and as the telegraphic material and stores were unfit for military purposes on a large scale, and had to be replaced by the Morse and needle systems, it was unable to do much in the way of telegraphy at the outset.

But soon the energy and practical sense of the Federals saw the necessity of taking over the telegraphs of the various private companies, and placing the telegraph *employés* at the disposal of the military authorities. A Field Telegraph corps was then formed, and accompanied the Northern forces in the field, using the existing and setting up new lines of telegraph. Telegraphy soon replaced signalling, and though the latter was still often used with the former at the extreme front, it was mainly by reason of the want of good telegraphists and Morse instruments.

Of course signalling was always used to communicate with the fleet, as a submarine cable can only be used with a ship at anchor.

Signalling certain common-place agreed-upon messages concerning the movements of the enemy may be done with the ordinary means at hand and by intelligent soldiers without previous training, but if lengthy despatches are to be sent it requires a well-trained signalling corps. The signalman stationed in a conspicuous position is often seen by the enemy, and if his signals are to be unreadable to the latter, some code must be used which the enemy cannot understand, or the cypher resorted to.

In the case of the enemy seeing the signalman, it requires four men to send and take down a message, viz., two to send and two to receive it. One puts it in cypher and gives it slowly to the signalman who sends it, and another takes it down from the signalman reading it, and puts it *en clair*.

Such a system is evidently then slow and clumsy. And, again, a signalman to be depended on in critical cases must be a man of very long training and experience, and he requires an exceptionally cool head to be of any real value under fire.

Signalling again is apt to fail entirely in heavy rain or snow, thick fog, and in a flat country, or thickly-wooded mountains, &c., where the view is very limited.

Seeing then that, as a matter of fact, in the North American War signalling, though it had the start, was soon superseded by the telegraph, and that a signal corps to be efficient must have a long and careful training, causing it to be an expensive item in an Army like ours—we can perfectly well do without it.

In a mountainous country, it is true, it would be often difficult to dispense with some kind of signalling, and signals might be sent over impassable obstacles or even over the enemy's head, but in Germany and the countries she is likely to be engaged in war in, such kind of country does not exist, and the only kind of signalling that she is likely to use would be on her north coast in conjunction with her Navy. Now we can perfectly well leave this to the latter where special care is devoted to the subject, and devote ourselves in the Army to the electric telegraph.

Next comes the question, can we use the telegraph in the line of outposts? and this is a question not easily answered. The war in Paraguay, it is true, is a good example of the way in which the telegraph can be used for directing operations, but it by no means proves that this can be always done, as the whole

campaign, from the moment Lopez's army retired to its own territory, was a purely defensive one, and it was merely a question of a slow retreat from one position to another carefully selected, strong by nature, and artificially strengthened. These retreats were so slow that only 400 kilometres were got over in 145 days, and in the stubborn but passive defence offered by the defenders the telegraph was often found working in the fighting line. Again, on the other side the slow advance enabled the telegraph to be used with the advanced troops. But this is no proof that the telegraph is an instrument to be used with the outposts, that is to say, that the line and office can be set up under fire.

On the other hand, in the Civil War in America, the telegraph followed the advancing columns and set up stations in the extreme front, and Fischer v. Treuenfeld gives us two examples :—

On the 27th June, 1862, the telegraphist Jesse Burnell established a station 300 feet behind the army of General Porter, drawn up in fighting line. During the fight at Gaines Mills this station worked without interruption, communicating with the reserves and General M'Clellan. Burnell was for hours exposed to the enemy's bullets and was only protected by a tree. It was only his extraordinary coolness and skill as a telegraphist that enabled him to work the instrument, especially when we remember he took the messages *by sound* in the noise of a general action. *Many of the messengers were shot, and every message was copied and sent in duplicate or even triplicate.*

Again, in a reconnaissance of the little town of Farrington, a troop of cavalry, under a Captain Smith, set up, under a telegraphist called Parsons, 6½ kilometres of wire. The troop was attacked and partly captured. *Parsons telegraphed under fire while slowly retreating with the rest of the troop, constantly connecting the telegraph.*

Now, as regards our own Field Telegraph Detachments it would appear that their efficiency is undoubtedly increased by—

1. The thorough theoretical and practical training of the corps intended for them, that is to say, the creation of a permanent telegraph corps ;
2. Diminishing the weight of the stores carried ;
3. Adopting a portable Morse instrument to increase tactical utility ; and
4. The general increased acknowledged utility of the telegraph throughout the Army, and the necessity for protecting it and giving it every assistance.

1. *The Telegraph Corps.*

The Telegraph Detachments formed on mobilization in the last war were found wanting in knowledge of the stores they were required to use in the field—that is to say, they had had little or no practice in setting up and taking down field lines or in establishing field stations.

Engineer Officers had some knowledge of the matter, but no fault could be found with the *employés* of the State Telegraphs attached to the Military Telegraphs.

These defects were seriously felt at first, nor did they wear off for some little time after the commencement of hostilities ; and it was soon seen after the campaign that, as all branches of the Service are trained in peace for the duties they have to perform in war, the same rule must apply to the Field Telegraphs. Now all arms of the Service have been perfected and increased since then, and the Field Telegraphs should be viewed with no more jealousy than the Field Railways. The result has been the creation of a Telegraph Corps, and it is only thus that the Field Telegraph Detachments may be fairly expected to come up to the increased requirements of the next campaign.

The training in peace must include the training of the men in the telegraph

schools, constant practice with the field poles and wire on flat and hilly ground—over marshes and water, through woods and towns—and the turning this to account at every opportunity, especially at manœuvres of all kinds and siege operations. For the Officers more is required; that is to say, a higher, and a more general knowledge of telegraphy in addition, in fact, much as is required of them in the other branches of military engineering.

Instruction in military telegraphy is given to Engineer Officers at the Artillery and Engineer Schools and to Officers of all arms at the War Academy (Staff College); this is of a more theoretical nature, but lays the foundation for further practical knowledge.

Two battalions of four companies each, formed of selected artificers and workmen, would appear to be sufficient to train in peace the necessary number of Officers and men required by the *twelve Field Telegraph Detachments* and the seven sections of the *seven Etappen Telegraph Detachments* required for erecting new lines, formed in war.

In addition, a certain number of non-commissioned officers may be so thoroughly trained in the use of the Morse as to be able to take the places of the *employés* of the State Telegraphs for ordinary duties, but the services of the latter are still indispensable for the more important work.

Every practised telegraphist knows the extraordinary value of a good *sound* reader—a thing only acquired by long practice. Many not only can take a message by sound, but can recognize the touch of the clerk who is sending it. The working of the *dot* and the *dash* is, in fact, read like music, and in process of time it becomes a second nature to many men. The value of such skill for military purposes is enormous, and consequently men like the *employés* of the State Telegraphs, who pass their lives at such work, are of immense value, as might be proved by cases over and over again.

2. *Diminishing the Weight of Stores.*

Constant attention has been paid to this, and the weights have been more or less diminished after every war, and only those stores that are absolutely indispensable are now carried in the field. Our experiences in the Franco-German War showed, however, that we had pretty well reached the extreme limit in this respect. The Morse instrument, it is true, might still be made somewhat lighter in some of its parts, but then the instrument would be of different pattern to that used by the State Telegraphs, and this is undesirable.

The poles are by a long way the heaviest item among the stores carried; and, on account of this, an endeavour was made after the Danish War to adopt an insulated cable without poles instead of the naked wire, and two Field Telegraph Detachments were equipped with it, and used it in the war of 1866. In spite, however, of the greatest care and attention in its manufacture and use, this cable has been discontinued; and, notwithstanding the many inventions and improvements since made, its general use has not as yet been decided on in any Army.

A field cable must be supple, perfectly insulated, durable, and strong; and it must, besides, fulfil two essential conditions—first, it must be light; and secondly, it must be able to resist the passage of the wheels of the heaviest vehicles on hard stony ground without affecting its insulation.

It is more than doubtful whether the cable introduced into the German Service answers these conditions, and, so far as the experience of the author goes, he is decidedly in favour of retaining the present wire and poles.

Still, the author prefers a well-constructed field cable to the Hooper's insulated wire used by us in the Franco-German War, as the former, with good conducting powers, is stronger both as to pressure and tension, and consequently can be used for longer spans and is less liable to be crushed. On the other hand, the weight is about one-fourth as much again; but the advantage on

the whole of the cable over the insulated wire, for use with the portable Morse about to be introduced, nevertheless outweighs this defect.

Wooden poles could hardly be made lighter than those in our Service, and they could scarcely be made shorter or thinner, and a lighter wood, having the same strength as the pine we use, would be difficult to find in Europe. The wire we use is thick enough, and the insulators are, as regards insulation, weight, and strength, all that can be desired. It only remains, then, to see whether the wagon could not be made lighter in itself, and this could be done by substituting steel for iron in those parts of it that are now made of the latter metal, and sheet steel for the present wooden sides. It is difficult to say how much the total weight of the wagon would be thereby reduced, but there is little doubt that it would be sufficient to enable the cable and portable Morse to be carried without an increase in the total weight.

It may as well be said here, that long and careful training in telegraph work in peace-time does not at once prepare men for duties in the field, and were our present training confined to the former we could not expect more of them in the next war than in the last.

The increased efficiency, in fact, of a telegraph corps in field duties as a war goes on was fully shown both in the American as well as in our last war, showing that both Officers and men lacked experience in the novel nature of the work at the outset. However, even with the best Field Telegraph corps, the setting up of the poles, the laying and stretching of the wire, and the other minor operations, must always take a certain time, and the only really rapid way of establishing a line is by using the insulated cable instead of the wire on poles, and the portable Morse instead of the office-wagon.

3. *The Portable Morse to increase Tactical Utility.*

The Buchholtz-Siemens outpost telegraph works well with the field cable, provided the latter contains a double, that is to say, a return, wire.

According to Buchholtz, 1 non-commissioned officer and 2 men can perfectly well lay and work this telegraph, which, packed with 1,000 metres of cable and other accessories in a specially made knapsack, only weighs 40½ kilogrammes, and can consequently be carried by one man. Several experiments have shown that 1,000 metres of cable can be laid in 10 minutes and taken up again in from 15 to 20; but such rapid work could hardly be reckoned on in war.

The portable Morse, without any earth connection, is then just the instrument for this, and can be at once used behind any kind of cover or in a dip in the ground. By lessening the weight of the wagon itself, each can take 1,000 metres of cable, and every other a portable Morse, so that there would be three of the latter to each Field Detachment, without increasing the total weight formerly carried.

Thus equipped for the field and trained in peace, there can be no doubt that much more may be expected of the Field Telegraphs in the next war, and we may see the headquarters, not only of Divisions, but even of brigades, in daily telegraphic communication with the higher headquarters.

The Field Telegraph Detachment would work, as a rule, with the wire and poles till nearly within sight of the enemy, and establish a station either in an office-wagon or in a house, &c. Thence the cable would be sent forward with the portable Morse. It is not, however, meant to infer by this that the portable Morse and cable could not, under circumstances, be used without the wire and poles altogether.

The telephone, as proposed by Siemens and others, finds no favour for military purposes with the author, as one of the first principles of military telegraphy is that the instrument should be *recording* for all important messages.

When we remember the immense value set by military men on distinctness and clearness in giving and receiving orders and instructions, and how the power of being able to express oneself clearly, concisely, and convincingly, is valued and encouraged in the profession of arms, we cannot fail to see that messages sent by word, and sent and received by inferiors, could not but be extremely unreliable. If mistakes occur under the most favourable circumstances, how much more are they likely to arise in the noise and excitement of battle?

In sieges, and especially in the defence of fortresses, the telephone, no doubt, might prove of great service for certain purposes.

4. *The General Increased Acknowledged Utility of the Telegraph in the Army.*

The difficulties that the Field Telegraph had to contend with in the last war, and the obstacles put intentionally or unintentionally in its way by the troops, may be said to be untold; it may, however, be accounted for by the fact that its use and importance was little understood by the Officers of the Army, to say nothing of the men. Often and often the lines of the French telegraphs were cut and destroyed by our troops with the idea that it was of use to the enemy, and soon afterwards had to be restored with immense trouble by our own people. Again and again was a telegraph column interfered with in its movements and work, and pushed on one side, and the most energetic representations and complaints of those responsible for its proper working remained unheeded.

As to a proper protection of the telegraph lines against the enemy, and especially against the franctireurs, it was at the commencement of the war out of the question, and it was only after a large number of troops were at the disposal of the General Etappen Inspectors that there was anything like security to the lines. The telegraph *employé* in his strange uniform (for he had never been seen in peace-time, not even at manœuvres) was not recognized by the soldier, and it was even apt to go hard with him when at any distance from headquarters.

The supply of stores was attended with the greatest difficulty, partly on account of the constant blocks and delays on the roads and railways, caused by the tremendous pressure of troops and war *matériel* of every kind, and partly owing to telegraph stores getting at first mixed with stores of other descriptions. The strictest orders were consequently given to the telegraph *employés* on no account to allow themselves *to get separated from the stores they had charge of;* but, in spite of this, stores were continually missed; and we may mention, as a case in point, that a large quantity of steel wire forwarded from Germany, and anxiously expected for weeks to complete a double line round Paris, was at last discovered to have been appropriated by a company of siege artillery, and *cut up to make fascine binders.* No wonder, indeed, the telegraph did not work as well as might have been expected!

But now that the Army knows of the formation of telegraph battalions, and, what is more, sees them at work at manœuvres in peace, it may be reasonably expected that such occurrences are things of the past.

Instruction in military telegraphy must be regularly given at the War Academy (Staff College), and the subject, though recognized as necessary for many years past, no longer neglected on the plea of want of time, as was formerly the case; one hour a week ought to be sufficient. Many Officers, and especially those who have passed the War Academy, show a liking for learning how to use the Morse, and opportunity has generally been afforded them of doing so in large garrisons and military stations, thus enabling telegraphy to be excluded from the curriculum of regimental instruction, in spite of the enormous advantages of having a few Officers in every regiment

who can telegraph. The necessity of a higher class of knowledge on the subject on the part of Engineer Officers has already been alluded to.

The instruction, again, of non-commissioned officers of all branches of the Service in the Morse, with a view to their employment by the State Telegraphs, is a necessary adjunct to the creation of telegraph battalions.

A. *The State Telegraphs.*

We now come to the question of the organization of the State Telegraphs as regards the services required of it in war.

Now, in the first place, it would be most unjustifiable to interfere in any way with the free development and expansion of the State Telegraphs as required in the general interests of the public in peace, by any measures calculated on the exigencies of war. Such a proceeding is entirely out of the question. On the contrary, every improvement in telegraphy and every additional line of telegraph laid in peace-time, increasing as they do the general use of the telegraph and the number of persons employed on it, must all the better prepare the State Telegraphs to render good military service on the outbreak of war.

Telegraphic lines like roads and railways lead from town to town, and converge on the larger towns of a country, especially on the capital. This is essentially the case at Berlin, where eleven lines of railway converge. Between all large towns there are special wires which are not connected with intermediate smaller places, and in addition to these there are international and other special wires joining the capitals and other places of importance in adjoining countries. These are of great use on the outbreak of hostilities, enabling messages to be sent from Berlin and other important military centres without any further arrangement to the centres of military preparation, and to the places of importance on the frontier where the Army is to be massed. Another advantage is that these wires are thicker than the wires used for mere local use, the necessity for less resistance being necessary for long distances, and much the same state of things would be found in any country that we might be called upon to carry war into. But Germany has another advantage, and that is her system of underground wires; this would certainly prove of great military use.

But however closely the country may be now covered with a network of telegraph lines, these would have to be supplemented, if our armies were to concentrate on the frontier, by temporary lines on by-roads, &c. Every year, however, sees some new line laid, and in course of time the temporary lines that would have to be laid would be very few indeed.

It is of great importance to have a complete plan of the telegraphs of the country kept up to date for military purposes, and the Director-General of Telegraphs is the proper person to see to this, and have ready classified the various lines existing as well as those that it would be necessary to set up in case of war. It is only thus that the State Telegraphs can be expected to at once enter on their military functions when called upon.

But this plan must not be confined to Germany alone. It should include all the neighbouring countries in which it is at all possible we might be engaged in hostilities, and this can be done from various sources.

All improvements and inventions in telegraphy adopted or approved of by the State Telegraphs should be examined by the Director-General, and if considered by him suitable for military purposes, adopted for the Military Telegraphs. An exchange of stores, again, is often very desirable, so that the Military Telegraphs should at all times have *the very best stores ready*. At the same time care should be taken that no great quantities should be kept in store, especially as regards the more perishable articles. It is far better to be constantly using the stores and replacing them by new ones. This has the additional advantage of preventing the storage or accumulation of obsolete or

antiquated articles, which, seeing the constant progress made in telegraphy, is a thing to be carefully avoided.

By international telegraphic conferences, treaties, exhibitions, &c., the Director-Generâl can find out the telegraphic arrangements of other countries and learn many hints that may be turned to account in various ways. He must above all things, however, get a clear insight into the organization of the Military Telegraphs of neighbouring States, and know how far the State Telegraphs work with them, that is to say, *whether both would be under the military authorities or only co-operate loosely.*

The absolute necessity of employing *employés* of the State Telegraphs in the field has already been alluded to; it is only in fact in work on such a large scale as that of the State Telegraphs that the necessary training and experience can be obtained. There are, of course, generally speaking, two classes of persons employed, viz., electricians and telegraph clerks. The latter are naturally by far the most numerous, and from them selected men are detailed in peace for service with the Army in war. These are employed at the manœuvres, and on mobilization would join the Military Telegraphs.

The non-commissioned officers of the telegraph battalions should be sent to stations on the State Telegraphs where they can thoroughly learn the use of the Morse, and afterwards rejoin their corps for further instruction in other matters. The employment of these men on the Military Telegraphs is no reason why they should not be constantly employed on the State Telegraphs, and their final appointment to the State Telegraphs on leaving the military service enables the Army to have the very best kind of men at its disposal in case of war.

It is evident that all this cannot be arrived at unless a perfect understanding exists between the Chief of the Telegraphs and the Inspector of Military Telegraphs, and the latter, it is unnecessary to add, should not only be a man of great technical knowledge, but should thoroughly understand the requirements of the Army in the field. Again, in war, the most complete understanding must exist between the Inspector of Military Telegraphs and the Director-General of Telegraphs. This *was* the case in the last war.

The Officers of the telegraph battalions should be thoroughly up to all improvements made in telegraphy, and what is more, given every opportunity of perfecting their knowledge.

In war the State Telegraphs must be prepared to supply both *personnel* and *matériel* to both branches of the Military Telegraphs. There is little difficulty in this as regard the Etappen Telegraphs, and, as a rule, the latter would act as a channel for supplying the Field Telegraph Detachments.

In the last war the State Telegraphs used such *transport* as was available, and as a rule there was no difficulty in the matter in Germany itself, where the railways did the work, but in the enemy's country difficulties constantly arose owing to the State Telegraphs, when thrown on their own resources, not having at all times the power or authority to procure the necessary vehicles.

The State Telegraphs must consequently be provided in peace with the necessary store and other wagons, and before taking the field receive proper teams and train soldiers. The number of carriages to accompany each Etappen Telegraph Detachment has been fixed at three store-wagons and a travelling carriage for the *employés*.

In the wars of 1866 and 1870–71 the State Telegraphs, being refused transport of its own, was obliged to put up with any wagons or carts that could be spared from the wagon parks, but after the great use made of the electric telegraph in the Franco-German War, there surely ought to be now no reason for not supplying it with the proper transport so much desired.

The Director-General of Telegraphs in the last war, bearing in mind the

failure in the war of 1866, provided the Military Telegraph Directions with the necessary wagons and carriages, and horsed them with the horses taken in the Battle of Sedan. Better touch was thus kept up at first with the Etappen Field Telegraph Detachments, but as the Army rapidly advanced, this fell off, and there were times when the Military Telegraph Detachments were short of stores.

If the State Telegraphs were provided with proper transport, such a state of things ought rarely to occur, not only on account of the existence of the transport itself, but from the fact that the transport being *military*, it would be better able to take care of itself.

The proportion of the various stores carried by the wagons of the Etappen Telegraph Detachments was on the whole found to be satisfactory, and it would be well for the present to adhere to it, as the fittings of the wagons are made to correspond.

In case the enemy's lines be found in the next war to be destroyed to a greater extent than was the case in the last, it would be well to have ready in the depôts on the frontier or in the stores of the Military Telegraph Directions large quantities of steel wire.

The further supply of telegraphists in the course of the war is certain enough. In fact, in the last war, it never failed in spite of the demands made on the State Telegraphs, and the latter would be fully able to meet still greater demands in the next.

Of the three store-wagons of the State Telegraphs, two would be fitted as those of Section No. 2, and one like those of Section No. 1 of the Etappen Telegraph Detachments. Each store-wagon would in addition carry an extra Morse instrument.

The two-horse travelling carriage for *employés* would be for the director and one or more assistants, and would carry two Morse instruments.

The State Telegraphs can provide workmen better than the Etappen Telegraphs, so that a permanent establishment of two foremen and eight artificers would seem to be enough for each column.

B. *Etappen Telegraph Detachments.*

We now come to the *organization of the Etappen Telegraph Detachments*, and the first question to be settled is their number.

At the close of the last war with France we had 7 Field Telegraph and 5 Etappen Telegraph Detachments of the North German Confederation besides 1 Bavarian and ½ a Wurtemberg Field Detachment (judged by our standard) at work, and these were *sufficient for the purpose.*

But in the next war more will be expected from the telegraph, much as from every other branch of the Service, and there is no reason why it should be found wanting.

The twelve Detachments alluded to met the requirements of an Army of twelve North German Army Corps including a Baden Division. Bavaria and Wurtemberg having their own telegraph corps are not included in this. Since then the German Army has been increased by two additional Army Corps, necessitating an additional Field Telegraph Detachment.

In the last war Falkenstein's Corps managed to do without any Field Telegraphs, and the existing telegraphs of the country did very well as Etappen Telegraphs; the French never managed to land on German territory, but it does not follow that in the next war with our neighbours they will not be able to turn their naval superiority to better account, and any Army watching our coasts must be provided with a Field Telegraph Detachment to enable it to grapple with any descent on our shores. Acting as it would on the defensive, it would hardly require an Etappen Telegraph Detachment, the existing lines being quite numerous enough to answer the purpose.

Should Germany be engaged in a third theatre of war, she would probably have for the time to act on the defensive, but yet be ready to take the offensive when the time came, and for this there should be a Field and an Etappen Telegraph Detachment.

Finally, there ought to be 2 Field and 1 Etappen Telegraph Detachments as a general reserve. So that in all there would be—

12 *Field Telegraph Detachments* (exclusive of Bavaria and Wurtemberg) and
7 *Etappen Telegraph Detachments.*

The Etappen Telegraph Detachments acting as a connecting link between the two lines of the Field Telegraph Detachments in front (joining the headquarters of the Army with the headquarters of Army Corps) and the State Telegraphs in rear, have two kinds of equipment, viz., one for erecting temporary lines, and another for restoring destroyed or disabled ones. The former consist of thin copper wire, insulated cable, and light poles as used by the Field Detachments, and the latter of strong thin pliable steel wire, enabling long spans to be used.

As both the stores and nature of work differ so greatly, the Detachment is organized in two sections, both under the Director of Etappen Telegraphs.

Section No. 1 consists of—

a. The technical staff of 1 telegraph inspector, 6 telegraph clerks, and 9 foremen artificers.

b. The detachment of 1 Lieutenant, 4 non-commissioned officers, and 31 men of the engineers.

c. The train detachment of 1 Lieutenant, 4 non-commissioned officers and 27 men.

Section No. 2 consists of—

a. The technical staff of 1 telegraph inspector, 4 telegraph clerks, 4 foremen, and 20 artificers.

b. The train detachment of 2 non-commissioned officers and 13 men.

The following is the transport allotted :—

Section No. 1.—6 six-horse store-wagons, 4 two-horse travelling carriages for the *employés*, 1 two-horse baggage-wagon, and 7 riding and 52 draught horses.

Section No. 2.—2 six-horse store-wagons, 3 two-horse travelling carriages for the *employés*, and 3 riding and 18 draught horses.

By providing the State Telegraphs with transport, the stores carried by the Etappen Telegraphs may be diminished by about one-sixth, as they can be more easily replaced. The following are the stores carried by the 8 store-wagons of the sections :—

31,000 metres copper wire, 2·2 mm. thick on 30 drums.
62,500 „ steel „ „ 20 „
9,380 „ insulated wire, 6 „ 30 „
313 „ insulated cable for crossing rivers.
25 kilogs. of binding wire.
750 poles 4 cm. thick, 3·8 metres long.
60 poles for crossing roads, 5·4 cm. thick, 3·8 metres long.
810 insulators, ebonite, with straight shanks.
540 „ „ swan-necked shanks with a screw thread and brass pins to prevent the wire getting out of the slit.
500 hanging insulators.
8 brackets with terminal insulators.[1]

[1] Not used in England.

8 iron jumpers.
16 sledge-hammers.
6 pairs of shears.
6 wheel-barrows (ladders).
2 jointed ladders 6·3 metres long.
8 iron hand-barrows.
26 tube joints.
50 iron wire stays.
16 pairs leathern gloves.
48 shovels.
24 picks.
24 hatchets.
24 axes.
3 straining tackles.

Besides tools and small stores.

The steel wire, the 540 insulators, with the S-shaped shanks, the 6·3 metre long ladder, the 3 straining tackles, the binding wire, and the tools and small stores of the line inspector are carried in the two store-wagons of Section No. 2.

The stores of the field lines are distributed among the six store-wagons of Section No. 2, so that each wagon carries sufficient of all kinds to set up about 6¼ kiloms. of line.

The insulator used with the field poles is carried on a strong iron shank 1 cm. thick, screwed for a length of 7 cm. into the top of the pole. The insulator projects about 15 cm. above the end of the pole, and the latter with insulator measures 3·95 metres in length over all. This height enables spans of about 50 paces to be used. The poles are fitted on the top with an iron ring or ferrule to prevent splitting, and the foot is cased in a pointed iron shoe. They are carried in the wagons with insulators screwed on, and to prevent the latter being damaged, they are made slightly less in diameter than the poles, 3·4 cm. instead of 4 cm. There are in every travelling carriage for the *employés* two Morse instruments with batteries, protected by springs to prevent them being injured by jolting.

C. *Field Telegraph Detachments.*

We next come to the *organization of the Field Telegraph Detachments.* The object of these is to establish telegraph communication between Divisions and the Army Corps they belong to, and if possible brigades as well. This requires great mobility, inasmuch as the lines are constantly being set up and taken down very often on the same day, and constant connection must at the same time be kept up with the State Telegraphs in rear. The latter work, it is true, may be looked upon rather as the business of the Etappen Telegraph Detachments, but it nevertheless requires the co-operation of both. In spite of all this, however, the stores carried by the Field Detachment must always be reduced to a *minimum.*

With the Germans the air-line on poles is the only recognized way of working, and the insulated cable with the portable Morse must only be looked upon as a means of prolonging telegraphic communication beyond the line to subordinate commands ; but in Armies that are called upon to operate in mountainous countries, on bad roads, and difficult ground, the cable carried on pack animals combined with signalling may be the only system practicable. At the same time, uninterrupted telegraphic communication with the base becomes often under such circumstances difficult, if not impossible. But in the German Service the case is different, and we may rest assured that the wire on poles is up to date, at any rate, as good a a system for the purposes as we know of.

If the roads are not carriageable or are blocked by troops or trains, or if it become necessary to run the line across country, and the heavy wagons would stick in the fields, we can use the wheel-barrows and iron hand-barrows. In the last war these were often used, especially the former.

If, however, the nature of the country or the proximity of the enemy prevents our doing this, we can, with the cable and portable Morse, follow the troops even to the main body (*Gros*) of the outposts. Beyond this it would not be safe to go as long as the fighting were of an offensive nature. When acting on the defensive or holding a position, however, we may even work the Morse in the line of outposts.

In thus fixing the limits within which we may expect the telegraph to work lies the best guarantee of invariably transmitting reliable information.

The store-wagons of the Field Telegraph Detachments, just as those of Section No. 1 of the Etappen Telegraph Detachments, should carry all the different kinds of stores necessary for laying a given length of line complete.

The *personnel*, &c., of a Field Telegraph Detachment is as follows :—

a. 1 Captain in command.
1 First Lieutenant of the Engineers.
1 Second „ „
1 Assistant Surgeon.
1 Field Telegraph Inspector.
6 „ „ Clerks.
1 serjeant-major.
1 1st class sergeant.
1 2nd „ „
2 1st class non-commissioned officers.
1 2nd „ „ „
2 3rd „ „ „
9 lance-corporals.
73 privates, including 1 bugler.
1 two-horse baggage-wagon.
11 train soldiers.
8 riding and 2 draught horses.

b. The train detachment consists of—
1 Second Lieutenant of the Train in command of the train.
1 1st class sergeant.
1 1st class non-commissioned officer.
1 2nd „ „ „
1 3rd „ „ „
30 train soldiers, including a shoeing smith.
6 six-horse store-wagons.
3 two-horse office-wagons.
1 four-horse general service wagon.
2 two-horse travelling carriages for the *employés*.
7 riding and 56 draught and spare horses.

The Field Telegraph Inspector is the assistant of the Officer commanding in all technical matters and in laying lines and establishing stations ; the clerks manipulate the instruments and attend to the stations.

The store-wagons, 12½ feet long by 4 feet wide, empty, are fitted in compartments to take the poles, wire drums, the wheels of the barrows, tools, insulators, &c.

To the right side is fastened the movable parts of the ladder or barrow, and on the outside are also fittings to receive the twelve rifles of the men when at work.

The office-wagons are fitted to enable two instruments to be worked at the

same time. These are carried in boxes, and protected by indiarubber springs.

The travelling carriages for the *employés* are two-seated "cabriolets." The place under the driver's seat is divided into two parts by a vertical partition. The front part contains the harness, &c., of the carriage and the train soldiers' kit, the rear part two Morse instruments with batteries and implements. The doors of the rear part, which work on horizontal hinges, act as tables for the instruments when fastened up, and when the carriage is used as office-wagon.

The wheel-barrow or ladder with iron hinges is used for carrying the wire drums, and for this purpose can be fitted with light iron wheels. When put together in its whole length it can be used as a ladder either for fixing the hanging insulators or joining the field lines with permanent lines. It can also be used as a step-ladder.

The iron hand-barrow, which takes to pieces, can be carried by two men, and is used when, owing to the character of the ground, neither the wagon nor the wheel-barrow can be used.

The following are the stores carried by a Field Telegraph Detachment :—

In the three office-wagons : 6 Morse recorders with 6 batteries of 10 elements each.

In the two travelling carriages of the *employés:* 4 Morse recorders with batteries of 10 elements each, and 7 iron earth tubes, and 3 clocks.

In the six store-wagons :—

24,800 metres copper wire, 2 mm. thick, on 24 drums.
11,300 metres insulated wire on 36 drums.
300 metres insulated cable for crossing rivers (in the general service wagon).
6,000 metres field cable on 18 drums.
600 poles.
60 poles for crossing roads.
660 ebonite insulators on straight shanks.
500 ebonite hanging insulators.
6 brackets with terminal insulators.
12 iron jumpers for boring holes.
21 wooden billets.
3 sledge-hammers.
6 pairs of shears.
6 poles 3·8 metres long, with hooks at the end for raising the insulated wire.
6 wheel-barrows.
6 iron hand-barrows.
18 indiarubber tube joints.
60 iron wire stays.
12 pairs of leather gloves.
24 shovels.
12 picks.
12 axes.
12 hatchets.

Besides tools, implements, and small stores.

It has already been stated that the field instrument should be simple and strong, easily carried, and be recording ; and that the instruments used by the Field Telegraphs should be similar to those used by the State Telegraphs, and that the Morse fulfils these conditions best.

The rules and regulations for transmitting telegrams are the same as those used in the State Telegraphs, and are merely simplified to suit the altered conditions, without affecting accuracy and despatch. The telegram forms are

slightly different, but the filling-in and dating, the way in which delays are treated, words reckoned, &c., are done according to the rules observed in the State Telegraphs. It is of course unnecessary to allude to the strictness of secrecy to be observed as regards the contents of telegrams; any breach of this is treated as a military crime. A set of instructions on the management, &c., of the batteries, and the use of the galvanometer, complete the rules and regulations for the Field Telegraphs. The galvanometer for testing the lines is of the pocket pattern.

The Electric Telegraph in War.

A. *On the Offensive.*

1. *The State Telegraphs.*

As soon as war is declared, telegraphic communication with the enemy's country is at once cut off on the frontier in such a way as to be easily re-established as soon as it is crossed. With countries in a doubtful attitude of course such a strong measure would not be taken, and it would be sufficient, under such circumstances, to examine all telegrams at the frontier before allowing them to reach their destination.

The use of the cypher would naturally be confined to our own officials, and the transmission of telegrams in a foreign language even put a stop to.

A sharp watch would be kept on the whole system of telegraphs in Germany, and all intercepted suspicious telegrams forwarded to Berlin, where an office would be established to receive, examine, and collect them, and forward such as are of military use to the proper quarter. The movements of troops, or the purchase of horses, stores, &c., or the collection of transport, and all such like occurrences having a military meaning, would come under this heading.

Submarine cables on the German coast that would be exposed to an enemy's landing would be taken up near the shore, and the portion coming under the immediate fire of our coast batteries would be cut off and replaced by a light insulated cable that could be easily removed. If the cable leads to a friendly or neutral State it is unadvisable to cut off telegraphic communication, both in the general interests of the public, and from the fact that important military information may be obtained through this quarter. If the shore-end of the cable is deeply embedded in sand and difficult to underrun, a length of light cable may be spliced in at some distance from the land, to be used instead.

Near the frontier where the concentration (*Aufmarsch*) of our armies is to take place, steps should be taken to have all places that are likely to be of any importance during this operation easily connected by telegraph. Temporary lines would have in many cases to be laid, and these would be best of thin steel wire, carried on light scaffolding poles which can generally be obtained on the spot without much difficulty.

As it would be risky to postpone the purchase of wire till the last moment, both on account of the danger of having to take from contractors at a pinch stores of an inferior description, and the possibility of the contracts not being delivered in good time, it is very desirable that a sufficient amount of *matériel* should be always ready in peace. Of course, as long as we are in our own country we can always use the ordinary thick iron wire generally used, but it is absolutely necessary that all the Telegraph Detachments and working parties cross the frontier supplied with good strong thin steel wire.

All telegraph offices in or near the rayon of concentration must be kept open day and night. The extra clerks required for this can be taken from other parts of the country.

The transport provided for the State Telegraphs should be at once equipped with *personnel* and *matériel*, and at once fully horsed and pushed forward to the frontier, so as to be able to follow the Etappen Telegraphs without delay. The first work it has to do on crossing the frontier is to make good all interrupted telegraphic communication, and to complete and improve the lines re-established or set up by the Etappen Telegraphs, connecting the head-quarters of the Army with the State Telegraphs of our own country.

In all probability the Etappen Telegraphs would find the enemy's State and private lines more or less destroyed, but in most cases a single wire could be established with the *matériel* of the destroyed lines, and if necessary with the help of the State Telegraphs. The latter must then establish a second wire, and ascertain whether another line running in a parallel direction cannot be found in the neighbourhood, or if not, laid as a temporary measure, at the same time keeping up connection with the Etappen Telegraphs, which must always be *in front*. To lay a second and parallel line a working party would be told off, but it must not take any of the store-wagons ; all these must invariably remain with the main body. A third working party, coming after the latter, would only have stores for temporary lines, and the lateral working party would have to get poles by cutting down trees or from the wood work of buildings.

The troops first advancing into the enemy's country may find the telegraphs completely destroyed, or they may be left intact as was the case in the Danish War in 1864. Anyhow, it will always depend on circumstances whether we can use the enemy's lines as we find them, or only can make use of such stores as are not included in the general destruction, such as wires, poles, insulators, instruments, batteries, electric bells, &c. Generally speaking we should have to choose a mean course on what principle we should work.

The Field Telegraph Detachments following the advance guard are, of course, the first that are called upon to act, and the Etappen Telegraphs give them every assistance they can in second line ; but the State Telegraphs have a far wider field for labour, inasmuch as it is their special duty to give a more solid and permanent character to the work done by the former, and generally arrange and organize according to the rules and customs of the State Telegraphs. The Military Telegraph Directions have to see to this as soon as any considerable portion of the enemy's country has been occupied. The Telegraph Director of the province bordering on the enemy's frontier where the invasion takes place is the fittest man as a rule for this work (provided, of course, he is an able man and can grasp military requirements), as he is likely to be well acquainted with the enemy's telegraphs working in connection with his own.

The best *matériel* for temporary lines is steel wire with light insulators, as it not only can be more rapidly and easily laid, but it can be more easily taken down if we have to retreat. The best lines of telegraph in a country are those of the State and railways, and these are the first to be seen to, provided, of course, their repair does not require too great an expenditure of labour and stores. Lines used for international or important home correspondence are the best for communication between headquarters and the base at home, such as Berlin. They have the advantage of being unconnected with intermediate stations.

The foremost working parties are far too busy with establishing telegraphic communication to be able to overhaul the enemy's telegraph stations, which, moreover, ought to have been previously cut off from the enemy's reach by the Field Telegraph Detachments in front. This is more the duty of the Military Telegraph Directors, who have to thoroughly search and examine all the enemy's telegraph stations, and ascertain whether any of the *employés* are about, and search for hidden wires which might still be used for hostile purposes. The same care must be used in searching for and making good

faults on the lines. These are often brought about by the most ingenious contrivances.

Of the enemy's telegraph stations we come across, those that it is desirable to use we should at once occupy and set to work, the remainder would be cut off, that is to say, the wires should be joined directly outside, and all earth connections removed. The wires leading to the office may remain, but all instruments and batteries should be taken away.

In our last three wars, on crossing the frontier, we found but slight injury done to the enemy's telegraphs, but we cannot reckon on this in our next war. If the enemy is prepared to take the offensive he, in all probability, will have thickened his network of wires on the frontier where he proposes to mass his forces; but if he intends acting on the defensive, he may have removed or destroyed all his lines for a broad zone along the frontier, and replaced them by only those lines that are absolutely indispensable, and these of a field pattern so that he can easily take them up on retiring. To the first case it is unnecessary to allude. In the second case we should have the greatest difficulty in establishing sufficient telegraphic communication, and twice or three times as many working parties would have to be employed with unlimited stores.

Telegraphic communication for railway purposes is more an affair for the railway regiment and the State railway *employés*, but in many cases the assistance of the Military Telegraph Directors might be desirable.

The latter must on all occasions see that the Commander-in-Chief's Headquarters, as well as the other headquarters, are always in telegraphic communication with the State Telegraphs. To increase facilities of telegraphing, as well as to avoid faults or interruptions, caused either accidentally by atmosperic disturbance or by the enemy's hand, the Military Telegraph Director should, by direction of the General Director, see that certain well chosen cross-lines are established, joining the lines leading along the Etappen lines (lines of communication between the armies and their bases).

2. *Etappen Telegraph Detachments.*

The work of the Etappen Telegraph Detachment of establishing telegraphic communication between the headquarters of the Army and the State Telegraphs is not such an undertaking as the work that falls to the lot of the State Telegraphs. It is, however, at times somewhat severe, that is to say, it has not unfrequently to establish long lines of
assistance of either of its sister branches, especially that of the Field Telegraphs.

It may happen that headquarters are moved from 18 to 23 miles in a day, and it is just on these occasions that little reliance can be placed on assistance from the Field Telegraphs. For this reason an Etappen Telegraph Detachment is provided with light field *matériel*, and organized so that both sections can work *independently*. If there are no existing lines of telegraph, or they are to a great extent destroyed, it is only by the greatest exertion that telegraphic communication can be established in the space of a day.

The Etappen Telegraph Director must invariably reconnoitre the line the day before, with a special eye to utilizing the existing lines of the country, and he should also, if possible, send the necessary stores to the spot in the night, so that there may be no delay in commencing work at daybreak.

The Etappen Telegraph Detachment would be content, as a rule, with establishing *a single*[1] wire. Other wires would be left just as they are, and

[1] Of course, if the Etappen Telegraph Director had time and leisure, and the circumstances of the case were favourable, he would not be content with one wire. For instance, No. 1 Etappen Telegraph Detachment was not only able, on the 5th of

wires that are cut or broken would be only so far made fast to the poles as not to touch the working wire.

The top wire is the easiest one to follow up, and on lines of railway the bottom wire should, as a rule, be avoided, both from the fact that it enters the stations, and is not, therefore, so easy to follow up, and because it is required for the use of the railway regiment and railway detachments. In examining and re-establishing a line of telegraph the greatest care must be paid to the detection of concealed faults. The following are the most common devices resorted to for making them :—

Winding all the wires round with very fine silver wire difficult to see.

Making connection with earth by means of a wire down the pole, or when an insulator is fixed to a tree, from the line to the tree.

Insulated shackles, especially where many wires meet.

Introducing a length of gutta-percha or indiarubber of the same thickness and appearance at places where the wire is subjected to no strain.

Filing cuts or notches in the wire, so that when it is subjected to any additional strain or a strong wind it breaks.

An earth wire may sometimes, but rarely, be found concealed in a hollow pole.

The telegraphist overhauling the line must from time to time put himself in circuit and work backwards ; it is only thus that he can ensure there being no breaks, faults, or leakages. He must at the same time keep a sharp look-out for branch wires.

Lines are generally found destroyed on a large scale in defiles where roads and bridges have been similarly treated. When posts are found destroyed they should be replaced by poles, spars, or rafters, and only as a last resource by the poles of the Field Telegraphs ; these should be looked upon as reserve stores for the Field Telegraphs Detachments, and if used should be at once replaced by the first working party of the State Telegraphs, and forwarded on with the least delay possible.

Steel wire enables long spans to be used, so much so that an interval between two or even more poles may not give too great a "sag."

If there are underground cables, the enemy, if retiring hastily, will, in all probability, have left them intact, or at any rate have only severed them at certain testing stations.

As a rule, it would not be advisable for the Etappen Telegraph Detachments to search for and repair underground lines. If this requires much time and trouble it had better set up lines with its own *matériel*. The insulated cable or insulated wire is particularly useful in replacing cables crossing rivers that have been destroyed, and the insulated wires are well adapted for replacing wires in tunnels, especially as the latter are generally carefully guarded.

The Etappen Telegraph Detachment very rarely has to work actually under fire, but is nevertheless sometimes exposed to hostile acts on the part of armed inhabitants, &c., and is often, from the very nature of its work, but scantily protected by the troops. It must, above all things, be constantly prepared to see its lines cut, and must, therefore, be well provided and know how to use portable testing instruments.

The State Telegraphs are better situated. They have a larger working *personnel*, and work among less disturbed surroundings. But the safest lines are those of the Field Telegraphs, as not only are they laid in a country thickly occupied by troops, but they have as well the protection of the armed engineer soldiers that lay them. The Etappen Telegraph Detachment again,

August, 1870, to establish communication in Weissenburg with five destroyed lines leading to the town, but on the same evening had two wires in working order to Sulz, and on the further advance of the IIIrd Army, the same number as far as Nancy.

besides having to expect little or no protection from its own army, may be congratulated indeed if it has not to put up with every kind of obstruction from this very army, as experience has shown to be more than once the case.

At any rate, much hard and thankless work is expected from it.

3. *The Field Telegraph Detachments.*

This branch of military telegraphy is, as its name implies, for work in the field, and its importance cannot be over-estimated.

Field Telegraph Detachments are not expected, it is true, to actually take part in the fighting, still they must be formed of Officers and men drilled and trained together as a military body previously in peace.

They have, it must be admitted, a certain amount of opportunity at manœuvres in peace of impressing other branches of the Service with their utility in war; this, however, only goes a short way. In the first place, the numbers of the troops brought together for manœuvres are very small compared with the masses used in actual fighting; and secondly, marches and movements succeed each other with far greater rapidity in real war, so that but little time is given for laying and taking up lines of telegraph.

To reasons of this kind, as well as to the faulty training of the detachments of engineers that were brought together at the manœuvres of 1868 and 1869 to form a Field Telegraph Detachment, must be attributed the want of confidence shown in the Field Telegraphs and the general belief that they were unsuited for war, in spite of their having proved their utility in two campaigns. Wrong impressions of this kind are now happily no longer to be feared, and if the Field Telegraphs can show in our next war that they can not only keep Army Headquarters in constant telegraphic communication with the Commander-in-Chief's Headquarters, as they managed to do in the war of 1870–71, but the former with the headquarters of smaller forces as well, seeing that the Field Detachments have been increased and improved in efficiency, both as regards *personnel* and *matériel*, we may be sure to see the electric telegraph considered as important as any other branch of the Service, and its indispensable assistance doubted by nobody.

The advanced guard which is followed by the Field Telegraph Detachment on foot must see that the enemy's telegraph offices are taken possession of. If the enemy's telegraph clerks are available, they may be made use of under the strictest technical surveillance, as by doing so valuable information on the state of affairs towards the enemy may be obtained. It is best to treat such telegraph clerks as prisoners of war, and on no account to leave them in the offices, as ways and means of telegraphing with the enemy are only too easily devised. A sentry should be placed over the office, and under ordinary circumstances the arrangements should be protected from injury till the arrival of technical advice.

The Field Telegraph Detachment must take precautions that the enemy does not get telegraphic communication round by the rear, and for this reason will often have to disconnect certain wires. If to do this the co-operation of other troops becomes necessary, the proposed expeditions must be laid before the senior chief of the General Staff present. The Officer commanding the Detachment, and his technical assistants, can see from the telegraph maps supplied them the position of the telegraph stations, the number of the wires, &c., and can tell whether any alterations or additions have been made by the enemy since the commencement of hostilities.

It is important to get possession of all junctions of telegraph lines situated on either side of the general direction of the advance. The connecting wires should not be destroyed, but merely disconnected from the line wire. The instruments should neither be taken away nor injured, but merely discon-

nected from all wires. The stations thus entirely cut off should be carefully guarded until the arrival of the first working party of the State Telegraphs.

There are very often lines of telegraph which are not covered by the enemy facing us, but by which he could, nevertheless, communicate with his base, or with other parts of the country, &c., in rear by a roundabout way. Flying expeditions may be sent to tap these lines, and to do this properly a skilful telegraphist provided with the necessary apparatus should accompany such parties. Under certain circumstances it may be only possible to cut or destroy these lines. If, again, we get possession of lines leading to the enemy's army, &c., we may often be able to deceive him by sending him messages purporting to come from his own side, but this can hardly be expected to succeed unless we can manage to send the telegrams in exactly the same form used by his clerks. Our State Telegraph *employés* are well acquainted with this from long intercourse with neighbouring States, and are therefore the men to be employed for such purposes. It need hardly be said such tricks as these must never be tried without the consent of the General Staff, and then only under the immediate directions of General Staff Officers, and they must be attempted with the greatest caution. On our side, again, these tricks may be tried against us by the enemy on our lines where they pass through woods, towns, villages, &c., and such places cannot be too carefully watched.

For these as well as for other reasons, lines of telegraph laid for military purposes are best parallel to the general direction of operations, and transverse lines are best avoided except in well-defined defensive or strongly occupied positions.

The work of the Field Telegraphs is very different from that of the other two sister branches, more especially that of the State Telegraphs.

In the first place, the headquarters of the Army Corps forming a strong Army, are more constantly shifting than those of the latter, and consequently the Etappen Telegraph Detachment which has to keep up telegraph communication between Army Headquarters and the rear is given greater breathing time between the moves than the Field Telegraph Detachments, which have to keep up telegraphic communication between headquarters of Army Corps and Army. Again, the Field Telegraphs have not only to set up their lines but take them down again, and they seldom can save themselves this trouble by using existing lines. If they can be spared the extra trouble of taking their lines down by using existing lines, the opportunity is only too readily seized.

A certain want of practice and skill is almost sure to be noticed among men of the engineers in the laying of telegraph lines, especially at the commencement of a campaign, nor is this indeed to be wondered at considering the many severe duties that are required of them. If the weather be bad, and especially if the ground be frozen hard, the setting up of the poles takes a long time, and it may happen, as it did indeed during the siege of Paris, that it took as much as an hour to lay a kilometre of field line, whereas skilled workmen could do four times as much under favourable circumstances. Running lines through towns and villages takes a considerable time, but not so through woods, if the wire used be insulated. If in the latter case the ordinary wire be used, the work very often entails a great deal of trouble, branches or brushwood must be cut away, and what is worse, the line constantly kept clear afterwards.

The first and most important step lies certainly then in the choice of the *best, shortest, and safest line* to be followed. Of course the first object is to get the line laid as quickly as possible, but there are other considerations; it must not interfere with the movements of troops, or it is sure to get knocked down, the store-wagons must be able to follow the line, and next there is the choice between the ordinary or insulated wire for certain lengths, and many

other points. In fact the Officer whose duty it is to select the line has sometimes anything but a simple job on hand, and only men who are naturally intelligent, quick, and well-trained in the business may be expected to do such work well.

With a view of getting the line laid as quickly as possible it is as well to commence work at several, or, at the very least, two places. The way in which the stores are carried in the wagons would indeed enable the line to be commenced at six different places, but such a proceeding would be exceptional, and as a rule the wagons, with their stores, would be distributed so as to get the work finished at the different places at the same time. If unforeseen difficulties arise that the Officer choosing the line has been unable to detect, such, as for instance, a rocky subsoil, the working party that first finishes its task proceeds to the spot where the work is delayed.

To lay an air-line with the plain copper wire, a *working party* of 3 non-commissioned officers and 20 men is told off into 3 squads, viz., *pole*, *wire*, and *reserve* squads. The first two consist of 1 non-commissioned officer and 8 men each, divided into 4 files of 2 men each, leaving 1 non-commissioned officer and 4 men for the reserve squad.

The *pole squad* begins work by setting up the poles. The non-commissioned officer paces off the distances of 50 paces, and 3 files drive holes at these intervals, the 4th file takes the poles from the wagons and sets them up in the holes. If the line leaves the road and the wagons cannot follow, the wheel or hand barrows are used. On crossing a road, the 4th file sets up on one side of it one of the special poles for the purpose. If the hanging insulators are used with the old pattern Hooper's insulated wire, or the new pattern field cable, the distances apart being 30 paces in the former and as much as 50 in the latter, they are fixed by the pole squads about 4 metres from the ground.

The *wire squad* completes the line, the 3rd and 4th files bringing up alternately the barrow with the wire, and the anchoring stays for the poles, and the 1st and 2nd files unroll and fix the wire.

As soon as the wire is fixed to the first pole set up and the latter is stayed, one man of file No. 2 places the wire in the insulator of the second pole, whilst the other man proceeds half-way between the second and third pole beyond, and after the two poles are set up, hauls the wire taut. In the meantime file No. 1 is busy in fixing and staying the first pole. The non-commissioned officer in charge, on seeing the wire sufficiently taut, gives the word "steady," on which the second pole is moved sufficiently sideways, one way or the other, till the wire is caught in the "⊥"-shaped slit in the insulator. The poles are fixed and when necessary stayed, and the insulated wire when used for short distances stretched, by the wire squad.

The *reserve squad* sees that the poles are properly fixed and stayed, regulates the "sag" of the wire, and sees that there is a free space of at least a metre round the wire, and in the case of branches and twigs more, if these are likely to be blown against it.

Lakes, ponds, marshes, rivers, or canals may be crossed in the following way :—

a. With the ordinary wire if it is not more than 140 metres broad, and there are no masted boats or vessels on it.

b. When it is broader than this but is not navigable, and there is a bridge, Hooper's insulated wire, or the new pattern field cable may be used, fixing it to the parapet wall or railing. It may also be weighted with stones and laid at the bottom, provided there is no danger of its being fouled by anchors, &c.

c. In the case of a broad river with a strong current and firm bottom, and especially if it is navigable, the sub-aqueous cable should be used. Strong pickets, 10 cm. thick, and standing from 1 to 1½ metres above the ground,

should be fixed on both banks and the cable made fast to them. The cable may be taken across by a bridge if there be one, or paid out from a boat.

Insulated wire instead of the bare wire may be used :—

a. In woods which are so thick that it would be impossible to keep the wire free.

b. When poles could not be fixed in the ground.

c. When it is desirable to lay the line as quickly as possible.

In all these cases great care must be taken in the selection of the line to be followed.

The *working party* is the same as that for the bare wire with poles.

The 1st squad carries the insulated wire, hanging insulators, &c., on the hand-barrow, the 2nd squad follows with the necessary tools and the ladder, fixes the insulators to trees, &c., stretches the wire, and clears away the branches that might possibly injure it, and the 3rd squad regulates the "sag" and sees that the wire is properly secured. Great care must be paid to joints or splices ; the ends of the wire should be bared before splicing and afterwards covered with a piece of indiarubber tape and lashed with a waxed end. If the splice is to be under water, a piece of waterproof indiarubber tubing should be drawn over the joint instead of the tape-binding, and securely lashed at either end.

The process is reversed in taking up a line, the squads remaining as before. Of course there is a difference in the case of an army advancing or retiring. In the former case the line may be taken up simultaneously at different points, but in the latter only with the office-wagon retiring with the rear-guard, so that the Officer commanding may at any time be put in telegraphic communication with the proper quarter.

In certain critical cases the telegraph must be kept working to the last, regardless of loss of line and instruments. In extreme cases too much importance should not be given to the safety of telegraph stores, as if lost the other branches should always be able to replace them.

The above may be taken as the usual way in which field lines are laid, slight variations being caused by different descriptions of country and conditions of warfare.

Our field poles have answered well : both poles and wire appear at first sight flimsy, but they are strong enough to withstand ordinary storms, and being so thin are rarely struck by shot. This enables lines of telegraph to be laid even where exposed to a heavy fire, but office-wagons, it is needless to say, cannot be exposed to such danger. On such occasions the portable Morse would be used, and if the bare wire on poles would appear too exposed, the new field cable, so that under the altered circumstances our Field Detachments could now carry forward the telegraph 6,000 metres further than formerly.

The conditions under which the portable Morse with the field cable would be used on the battle-field must constantly vary just as do the conditions of the fighting itself, and only very general rules can be laid down for the guidance of those using it.

These are :—

1. To try and get as direct communication as possible with those in command, so that there may be the least possible delay or chances of mutilated telegrams.

2. To establish the station in a well-sheltered spot, as for instance the cellar of a house, or if there are no houses, behind trees or cover afforded by ground, near the position of the Officer commanding the Division, Army Corps, &c.

3. To lay the cable so that it may be safe from injury, or bury it in the ground.

If there are several cables diverging from where the wire carried on poles

ends, there should be an office-wagon or some sheltered and covered station at this point, so that the man in charge may be able to use the switch without excitement or flurry.

As we have already pointed out, the main factor of success lies in the training of the Field Telegraph Detachments, and this necessitates a permanent telegraph corps in peace-time.

The inspection and repair of the air-line is generally done by one of the telegraph clerks using a pocket galvanometer, and travelling in a carriage accompanied by an artificer. Beyond this the cable line would be looked to by a good non-commissioned officer.

B. *On the Defensive.*

The Prussian Army, trained in the spirit of the offensive since the days of the Great Frederick, and admirably organized to this effect, has managed in the last two great campaigns to carry the war into the enemy's country and there dictate its own terms of peace. And in both these cases the enemy had been quietly preparing for war according to his own system long before we took the first step at mobilization.

The peace-loving qualities of the German nation are well known. There is no desire for war in Germany, and we may rest assured that mobilization will be postponed so long as there remains the faintest hope of preserving peace. But this very circumstance may find us at the last moment behindhand, and it would be dangerous to ignore the fact that we may be compelled to act partially, at any rate for a time, on the strict defensive. As regards our western neighbours, such an advantage on their side at the outset would be highly prized. Again, supposing the French attacked us by land and by sea suddenly in overpowering force, and we were at the same time attacked by another neighbouring State in another quarter, we should certainly have to calculate on a strictly defensive attitude, at any rate for a time. Neither of these contingencies should be lost sight of.

Telegraphs on the defensive should be looked upon separately, as (1) the lines laid and worked for purely military purposes at the time; and (2) the permanent lines covering the country and connecting us with other countries. We certainly might be justified in entirely cutting off all telegraphic communication with foreign countries, but we should surely suffer by such a step, and it is certainly not in the modern Prussian spirit of carrying on war to do so. At any rate, it could only be thought of under very exceptional circumstances.

For this purpose to simply cut the lines on the frontier would not suffice; it would be necessary to remove all lines for a broad space along the frontier threatened, and thus create a wide isolated zone between us and the enemy. The country to be thus abandoned would have all its lines, including the poles, and to a certain extent its underground lines as well, removed, and where necessary field lines set up, which could be taken down as our armies retired. An isolated zone of this description would be from 45 to 70 kilometres, or some two or three days' march broad, and would be best situated behind some marked natural features.

Telegraphic arrangement must of course vary with the military situation. It may be useful to ensure timely concentration of the retiring forces either for the purposes of assuming the offensive, making a stand, or retiring from the scene altogether, &c.

We have already alluded to the telegraph as far as it is concerned in the defence of our North Sea and Baltic shores. Enough has been said to show the part it would play in the question of coast defences, submarine mines, and the concentration of troops on threatened points.

The three branches of the Military Telegraphs might be called upon to work

as follows on the defensive, and the retiring troops would have to see to the safety of the *employés* and stores of the Etappen and State Telegraphs :—

1. *The Field Telegraph Detachments* would have to establish the temporary lines and stations in the isolated zone, and, if necessary, would fall back on the stores of the Etappen Telegraphs. The latter would have to assist in taking up the lines in case of a retreat. If all the *matériel* of both these branches were expended, recourse would be had to the State Telegraphs.

On this side of the isolated zone the Field Telegraph Detachment which has to keep up telegraphic communication between Army and other head-quarters, would accompany the former, and establish flying lines where these would be necessary to supplement the existing lines of the State Telegraphs; this would generally be done when the Army is likely to occupy the same positions for any length of time.

The Field Telegraph Detachments would not as a rule destroy abandoned lines, nor make hidden faults in them, they would leave this to the State Telegraphs, and only assist the latter if required.

2. *The Etappen Telegraph Detachments*, which in a retreat, just as in an advance, have only to secure telegraphic communication between headquarters and the State Telegraphs, would in the former case only have to lay fresh lines of telegraph when the army is pressed off its line of operations, as otherwise the army has in its rear the existing network of telegraphs of the country with all its well-appointed lines and stations.

The Etappen Telegraph Detachment takes up the lines it has laid as soon as headquarters move off, but it should be careful not to do this too soon with the wire communicating with the rear-guard. If the rear-guard is retiring on roads where there are no existing lines of telegraph, a flying line would have to be laid with the field *matériel*.

3. *The State Telegraphs.*—The work required of the State Telegraphs in a defensive war is perhaps of a heavier nature than in an offensive one. The alteration of existing arrangements to suit the military requirements of the situation is an affair requiring much time, trouble, and foresight, and much more is required by an army in this respect standing on the defensive than if it were rapidly advancing.

To entirely remove all telegraphic arrangements in the isolated zone is a work requiring both great care and energy. All instruments and stores of any value that are easily moved should be taken away, and poles should be either burnt or cut up. Cables in rivers should be cut and disconnected from the banks if there is no time to remove them. Underground lines should be removed for a length of a few yards at testing stations, and cut besides at one or more points between these, taking care to remove all traces of the excavations made for the purpose.

When a rapid retreat is made with the prospect of soon resuming the offensive, the destruction would only be of a partial description, and would be carried out in places where the enemy would have difficulty in restoring the lines, such as in defiles, at corner supports, poles where the line crosses roads, &c., on viaducts, in towns and villages. On such occasions, hidden faults in the line would give the enemy much trouble, and often cause him to lose more time in trying to find and remedy them than in laying new lengths of line.

All such work must be done systematically by well-trained men working in sections under good foremen, and furnished with the necessary tools and appliances.

Telegraph clerks should be instructed how to act on abandoning their stations, so that these may be kept working to the last moment, and the neighbouring stations informed of the fact, and both *matériel* and *personnel* finally removed by the retiring troops.

Our railways, and the telegraphs connected with them, are destined, in the

case of a defensive war, to play a very important part, but our *underground wires* will certainly, far more than any system of overhead wires, greatly add to our powers of defence.

Both from a military as well as a technical point of view, these underground wires would certainly be best run along the line of those railways which are of especial importance in case of war. These lines are already encumbered with numerous overhead wires, necessitating in most cases a double row of poles, and it appears undesirable to further increase these; but a line of railway, with its clear space on either side and side-drains, is the very best position for underground wires, and as in the case of war these would in a great many cases be the only ones in working order in the immediate vicinity of the enemy, there ought to be no objection on the part of the railway companies to the excavations necessary in laying them. The State Railways indeed can always be relied on as favouring the movement.

Railways again, as a rule, mark the shortest distances from one place to another, and, in most cases, do not lead through small places, whereas roads invariably do so. Thus railways mark the shortest and cheapest lines for underground wires, and the safest as regards the chance of discovery by the enemy.

C. *In Sieges.*

The part played by the telegraph in a siege is much like that played by it in defensive warfare, even on the side of the besiegers.

In the immediate neighbourhood of the fortress, the cable, as a rule, is the only means of telegraphing, and it has often to be buried if exposed to artillery fire. If air-lines are used at all, they would be of the field pattern, and would be used by the besiegers to connect the cables in the trenches with the lines established by the State Telegraphs. It would be only in the case of great sorties by the garrison, or the taking by storm of outlying works of the besieged, that anything like the *offensive* use of the telegraph would come into play, that is to say, the pushing forward of the portable Morse with the field cable under a heavy fire.

If the country round the fortress has been cleared of all telegraph lines, the State Telegraphs of the besiegers would have to establish a thick network of lines, so that all the troops, the engineer and artillery parks, the various depôts, &c., may be all closely connected by telegraph.

A line of telegraph would be completed right round the fortress by the besiegers, so that all parts of the line of investment should be at all times in immediate telegraphic communication with the headquarters of the besieging force.

In the case of the siege of a very large fortress like Paris for instance, where not only sorties on a large scale have to be met and repulsed, but relieving armies defeated and driven off, one line of telegraph would not be enough. As was done before Paris in the last war, two lines, an inner and an outer one, then have to be established, each provided with numerous wires. The inner one would be used by the troops actually engaged in investing or attacking the place, and the outer one by headquarters, and the different commands of the besieging or investing force, and the forces in the field facing he relieving armies of the enemy.

1. *The Besieged.*

The telegraphs of a fortress should be carefully laid out and organized in peace-time. Underground cables, protected by a sheathing of galvanized iron wire and bedded in asphalte, should be buried at least 1·50 metres deep, so that they may not be reached by heavy shells. They should be laid, first with a view to assist in the defence of the place, and secondly with a view to economy.

The central station would be in the quarters of the fortress Commandant, which in a siege would be in a bomb-proof casemate.[1] Hence the wires would diverge to important points in the enceinte, and, beyond this again to the detached forts and batteries. By means of a switch the Commandant can then communicate with each work separately or in groups. The underground cables, which would generally contain a single insulated wire only, may be laid alongside each other, but to avoid induction currents should then, under certain circumstances, be not less than ·3 metre apart. On the front or fronts attacked, the number of wires, of course, should be greater than on others, and every detached work attacked *en règle* should be connected with the central station by more than one line to provide for accidents. The keeps of the detached forts, and the large caponiers and casemated keeps or barracks in the enceinte, &c., which in peace are used as quarters, should all be connected by telegraph.

Other reduits not used in time of peace as barracks, but which might play an important part in a siege, may also be connected with the central station by underground wires beforehand in peace-time, as it is unadvisable, for many reasons, to leave this to be done on the eve of an investment, when there are so many things to be thought of.

All the underground lines above alluded to radiate more or less, like the spokes of a wheel, from the central station, either to terminals or junctions. But another kind of line must follow more or less the perimeter of the fortress, so that the different parts in it that may have to act together, such as reduits, caponiers, batteries, powder magazines, &c., may all be in direct underground telegraphic communication with each other. And to put all these points in direct communication with the central station as well, this line would lead either into stations established on the radiating lines before alluded to, or be taken direct to the central station itself.

Under certain circumstances, it may be advisable to have the important outworks of the enceinte connected with underground wires, but this does not apply to the covered way unless it were palisaded, and provided with blockhouses. The ordinary field cable buried $\frac{1}{2}$ metre deep behind the palisades, or in the earthen slope of the counterscarp, would then answer the purpose quite well enough.

The above must only be taken as a general indication of what would have to be done ; details must vary in every case according to the system of fortification, the position and grouping of the works, topographical features, and other considerations. We have, however, generally speaking, but one type of fortress, viz., an enceinte forming a *reduit*, a girdle of detached independent forts forming the exterior line of defences, and a system of sectional defence (*Abschnitts system*) with a view to offering a stubborn resistance at every step in the attack, and the general plan of the telegraph system of the place must be laid out in accordance with this ; but there are also some other considerations.

The best defence of a fortress, and which is in accordance with the spirit and traditions of the Prussian Army, lies in meeting the enemy boldly with the bayonet at close quarters at every step in the attack, that is to say, directing sorties on a large scale against his establishments, parks, depôts, batteries, &c., and small sorties against his works of approach. By conducting the defence on these principles, a besieger's rest is constantly broken by night and day, and he is compelled to act with the greatest caution, and restrict himself to the use of the slower and more tedious kinds of sapping.

In all this the telegraph is of the greatest value. Everything seen or observed by the outlying sentries or posts of observation, can be immediately

[1] The fortress Commandant's quarters being in peace-time in an ordinary dwelling-house, the latter should be connected with the siege quarters for every-day work.

wired to the fortress Commandant, who can at once take such steps as may be necessary, and the progress of every sortie can be constantly communicated to him if the Officer in command be only provided with a portable Morse and a length of field cable.

The value of outlying independent works is thus very conspicuous. One serious defect formerly recognized in fortresses with detached forts was the number of subordinate independent commanders who, if left to themselves, might not always act in accordance with the views of the Officer commanding the fortress. With a proper system of telegraphs, it is needless to say, this defect at once vanishes, and the telephone, in spite of its defect of being a non-recording instrument, may, as an exceptional case, be used in this kind of warfare with advantage, especially when sending lengthy instructions or information. Underground single-cored cables buried either singly or at a distance of ·3 metre apart are little liable, seeing their lengths in this case, to be affected by induced currents, and means are at hand of sufficiently deadening the noise of artillery fire.

To prevent the besieger from using any of the underground wires that he might find in ground abandoned by the besieged, the latter would render them useless to him by passing strong electric currents through them of very high tension or potential from magneto-induction apparatus.

To establish a complete system of underground wires for a large fortress is a very expensive undertaking, and would only be absolutely necessary in the case of first-class fortresses near the frontier. The work would be confined in other fortresses, according to their importance, to laying only such underground wires as appeared of special importance, and more particularly those the laying of which would take considerable time, or at times might be attended with great difficulty, as, for instance, where the ground was of a rocky nature, where lines had to be carried under foundations of buildings, across rivers that might be frozen, &c. In very large fortresses, a good system of telegraphs has proved to be of immense use in peace-time, and this has no doubt something to say, in the first instance, towards the establishment of an underground system of wires which would prove so valuable in case of a siege.

2. *The Besiegers.*

As soon as regular approaches are commenced, underground wires, it is almost unnecessary to say, must take the place of air-lines. And as the shells from heavy siege guns may, in many cases, range considerably beyond the first parallel, air-lines even very far in rear of it, when they cannot be concealed from the view of the besieged, are best made of the field telegraph *matériel*, as this offers so small a mark.

In the more important lines, such as, for instance, those leading from the parallels to the headquarters of the Officers commanding the artillery and engineers, there should be at least two wires either overhead or underground, as the case may be; and these would then be connected with the cable following the zigzags. This cable would be the ordinary field cable, and would be buried some ·3 metre deep just in rear of the steps or banquette of the parallel or approach after the latter was finished off. By this time most of the telegraph stations would have been fixed on, and the wires leading to them cut and arranged for connection. They generally would be in blindages established in the parallels.

Sorties are generally directed against the flanks of parallels and works of approach, and it is consequently there that posts of observation, connected with the telegraph, should be established to give warning of their advance. Of course where the flanks are secured by natural obstacles such precautions are not so necessary.

If the attack *en règle* succeeds in reaching the foot of the glacis, the cable

may be afterwards used in a variety of ways; it may be used in mines and galleries, carried forward over breaches, across ditches, into works that have been stormed, &c., and the portable Morse may even accompany storming parties, and at once establish telegraphic communication between them and the stations in the third or fourth parallel or lodgments in the covered way.

All telegraph work in the attack of a fortress between the permanent lines of the State Telegraphs and the most forward lodgments made in the works of the besieged, is best done by the Field Telegraph Detachments, as the Officers of these Detachments, being Engineer Officers, are well acquainted with the various operations connected with a siege.

(To be continued.)

COLONEL v. LÖBELL'S[1] ANNUAL REPORTS UPON THE CHANGES AND PROGRESS IN MILITARY MATTERS DURING 1883.

By Lieutenant-Colonel H. HILDYARD, Highland Light Infantry.

THE first number of this useful military publication, by Colonel v. Löbell, appeared in 1875, since which time he has fully maintained the programme then put forward, by which he proposed to reproduce annually a complete record of all military changes in organization, drill, and tactics which had taken place, not only in the principal European armies, but also in all parts of the world. During the brief period of its existence it has had to record the complete reorganization of most of the military Powers, and though during the past year there have been no changes on so large a scale, the volume for 1883 does not on that account lack interest, though a larger portion of it than usual is occupied with other matters connected with the military art.

Germany.

As is necessarily the case, Germany, having been the foremost in reorganizing her army according to modern ideas, has had few changes in organization, and even new regulations have been very limited. It is worthy of notice that by a Royal Order, dated the 4th September, 1883, the regulations in force for the promotion of Officers prior to 1823 have been reintroduced. They are briefly to the following eflect :—

1. Each regiment and rifle battalion, the general staff, the engineer corps, the train, and the artillery are to form in themselves a separate corps for the purposes of promotion up to the rank of Field Officer.

2. The list by rank of Officers in each corps is to form the basis for promotion, only those being recommended who are certified to be qualified in every respect.

3. Qualified Officers on the unattached list of regiments are to be promoted with, but after those serving with the colours, up to and inclusive of the rank of Captain. Advancement to a higher grade is only to be allowed exceptionally by the special sanction of the Emperor.

4. Promotion to Lieutenant-Colonel and to the higher ranks is to be based upon army seniority.

In case, however, of notable inequality in the rate of promotion in the several corps, the difficulty may be met by making transfers from one body of troops to another.

By an Order of November, 1883, in time of peace the senior Field Officer of each infantry regiment is to be attached to the regimental staff as second in command of the whole regiment, so as to replace the Colonel when absent, or employed on special duties. Both he and the three Officers in command of battalions are to be Lieutenant-Colonels in place of Majors, as heretofore, the change being effected gradually.

The increased importance attached to the instruction of the troops in musketry has led to a short course being introduced at the School of Musketry

[1] Jahresberichte über die Veränderungen und Fortschritte im Militärwesen. 10 Jahrgang, 1883, herausgegeben von H. v. Löbell, Oberst z. Disp.—Berlin, Ernst Siegfried Mittler und Sohn. 1884. Pp. 537; size, 9·5″ × 6·5″ × 1″; weight, 1 lb. 14 oz. Price 8*s.* 6*d.*

at Spandau, which is to be attended by regimental and battalion Commanders of infantry.

General Staff Officers attached to districts in which fortresses are situated are to attend heavy artillery practice at the nearest ranges, whilst those belonging to Army Corps and Divisions are to witness field artillery practice, so as to allow of their becoming more intimately acquainted with the employment of that arm.

China.

The recent events on the coast of China have directed special attention to the military capabilities of that country, and the "Jahresberichte" has some remarks on the subject which are not without interest. During 1882 and 1883 the purchase of artillery and small arms was made by China on a large scale, Krupp alone having delivered 362 field guns (of 3, 7, and 9 cms.), 12 siege guns (of 12 cms.), 156 heavy guns (of 12—21 cms.), 16 coast battery guns (of 21—24 cms.), and 40 ship's guns (of 8—30·5 cms).

This marks the progress made in her armaments; but it is nevertheless certain that China does not as yet possess an army so organized as to be in a position to compare with European troops. Still, as compared with 1860, her improvement is marked, more especially as regards coast defences. The masses of troops which were assembled on the Russian frontier on the north and west at the time of the Kuldja difficulty, and more recently on the Tonkin border, were, though formidable in point of numbers, without tactical organization and consistency, neither armed nor clothed uniformly, and were wanting in modern requirements, both as to organization and command.

An opponent, however, will be no longer able to land without danger and difficulty and march upon Pekin. After disposing of the fleet of heavily armed gunboats, which before the late bombardment of Foochow numbered thirty-two, there will be the dangers of a torpedo conflict to be encountered before reaching the forts. These have been erected of late years at all the more important points on the coast, notably at Canton, in the Gulf of Petchili, at Takoo, Pehtang, and along the Peiho to Tientsin. They are constructed on the most modern approved principles, and are armed with heavy Armstrong and Krupp guns, protected in some instances by plated cupolas.

The troops destined for the defence of this most important portion of the Empire are the best of the Chinese forces which form the Pekin Army as reorganized by Li-Hung-Chang.

In Tientsin a torpedo school was established in 1882, under the superintendence of a German.

France.

The only important change made in the organization of the French Army during the past year relates to the Artillery. The law of reorganization of the 13th March, 1875, by which the whole Army was remodelled, provided for 57 foot batteries for employment in the fortresses and coast works, and of these 12 were permanently allotted to Algeria. This left France proper with only 45, a strength altogether insufficient, even in time of peace, and it was found necessary to augment them by 51 new batteries, if the duties were to be properly performed. But as this would involve the existing formations being practically doubled, it was determined to place this branch on an entirely new footing by separating it altogether from the Field Artillery, so far at least as the non-commissioned officers and men were concerned.

It might have been thought that with so extensive a force as was contemplated it would have been found expedient to separate the Officers as well, so as to avoid the many inconveniences which, as we know by experience, a general list entails. But this has not been done, and in the preamble of the new law dealing with the reorganization of the Foot or Garrison Artillery,

the reasons for this are given. In the first place the Officers serve for a longer period than the men, which affords them the opportunity for mastering the details of both services, which the men have not the time to do. This being so, apart from the inconveniences of transfer on promotion and the change from a popular to what is generally considered an irksome service, much is to be gained by the most varied experience possible being ensured for the Officers generally. There can be no question but that the State is a gainer by the decision arrived at, though it is probable that the Officers of Artillery generally will have been disappointed at it.

The new organization provides altogether for 16 Foot or Garrison Artillery battalions, each of 6 companies; 38 Field Artillery regiments, formed into 19 brigades, viz., 1 to each Army Corps (of the 2 regiments forming each brigade, the first is composed of 12 Field batteries, and the second of 8 Field and 3 Horse Artillery batteries); 2 Pontoon regiments, each of 14 companies; 10 companies of Artillery artificers for the repair of *matériel* of the Artillery, Engineers, and Train; and 3 Laboratory companies.

The composition of the Foot Artillery Battalions was fixed as follows:—

Staff: 1 Chef d'escadron as Commandant, allowed 2 horses.
1 Capitaine-Major, with 1 horse.
1 Lieutenant as Paymaster, with 1 horse.
1 Lieutenant as Quartermaster, with 1 horse.
1 Surgeon-Major, 2nd Class, with 1 horse.
1 Trumpeter Corporal.
1 Armourer.
3 Maréchaux des logis (wagon-master, store officer, and secretary).
1 Fourier.
5 Corporals (clerks, artificers, and fencing inspector).
5 Gunners (writers and artificers).

In all 5 Officers, with 6 horses, 16 non-commissioned officers and gunners.

Each of the 6 companies is composed of the following:—

1 Captain Commandant, with 1 horse.
1 Captain of the 2nd Class, with 1 horse.
1 1st Lieutenant, with 1 horse.
1 2nd Lieutenant or Sub-Lieutenant, with 1 horse.
1 Adjutant.
1 Maréchal des logis chef.
7 Maréchaux des logis.
1 Fourier.
8 Corporals.
5 Laboratory men.
4 Workers in wood.
2 Trumpeters.
100 Gunners, of whom one-third are of the 1st Class.

In all 133 of all ranks, and 1 boy.

A Foot Artillery Battalion, therefore, has the following establishment:—

29 Officers with 30 horses.
190 Non-commissioned officers, corporals, and men belonging to the staff.
600 Gunners.
6 Boys.

The distribution of the battalions will be as follows:—

1st battn. (place of formation Douai) Lille, with companies at Havre and Dunkirk.

2nd battn. (place of formation Versailles) Valenciennes, with companies at Maubeuge and Givet.
3rd „ (place of formation Laon) Rheims, with companies at La Fère and Angoulême.
4th „ (place of formation Châlons) Verdun, with companies at Longwy and Montmédy.
5th „ (place of formation Poitiers) Verdun, with companies at Angoulême.
6th „ (place of formation Orléans) Toul.
7th „ (place of formation Bourges) Langres, with companies at Fort Domont and Paliseau.
8th „ (place of formation Toulouse) Epinal, with companies at Le Mans and Manonvilliers.
9th „ (place of formation Vincennes) Belfort, with companies at Besançon.
10th „ (place of formation Besançon) Besançon, with companies at Dijon and Montbéliard.
11th „ (place of formation Clermont-Ferrand) Lyons, with companies at Castres.
12th „ (place of formation Grenoble) Grenoble, with companies at Briançon and Valence.
13th „ (place of formation Nismes) Nice, with companies at Tunis, Toulon, and Vannes.
14th „ (place of formation Tarbes) Bayonne, with companies at Perpignan and Vannes.
15th „ (place of formation Rennes) St. Malo, with companies at Cherbourg, Brest, and Bourges.
16th „ (place of formation Paris) Paris.

It will be seen from this that the majority of the battalions are on or in the vicinity of the Eastern frontier.

The establishments of the two field artillery regiments of each brigade are fixed as follows by the new law :—

	1st Regiment.	2nd Regiment.
Superior Officers	8	8
Other Officers	56	52
Non-commissioned officers and men of staff	434	401
Gunners	840	776
Officers' horses	98	92
Other saddle horses	271	339
Draft horses	384	340

The pontoon regiments, artificer companies, and laboratory companies retain the same establishments as heretofore.

The formation of the new foot artillery battalions necessitated an increase in the number of effectives over that of the foot artillery batteries, previously existing, of 329 officers and 8,511 of other ranks, together with 300 horses. To obtain these without materially increasing the estimates, the expedient has been resorted to of breaking up the existing 57 artillery train companies, and incorporating their *personnel* and horses in the new formation. In time of peace these train companies were found not to be necessary, as the duties they performed can be undertaken by the field artillery and *train des équipages*, whereas in time of war the necessary formations are to be drawn from the field artillery.

The 57 train companies, therefore, together with the 45 foot artillery batteries in France, are broken up and incorporated, partly in the field artillery; but the greater bulk of them goes to form the new battalions. In

Algeria the 12 foot batteries exisiting under the old organization are to be continued provisionally.

A new law governing promotion has been introduced, by the adoption of the recommendations of the Army Commission, presided over by the Marquis de Roys. While this retains in principle the provisions of the law of 1832, some important changes are made. No one is to be promoted to a higher grade who does not possess the necessary qualifications. Corporals and brigadiers are to be appointed to the rank of non-commissioned officer after four months' service in those appointments. The promotion of the latter to the rank of Officer will be made by selection alone, after a service of at least two years with the colours as non-commissioned officer, and after having obtained the prescribed certificate at a school of instruction. The rule already in force in the Artillery and Engineers by which Sub-Lieutenants are promoted after two years to the rank of Lieutenant is extended to the other arms.

Promotion to the rank of Captain and to the higher grades is dependent upon passing the necessary examinations, which are to be conducted by specially constituted Boards. Only the names of Officers which are included in the first half of the seniority lists are to be submitted in the annual lists for promotion sent in by the 31st of March. Those Captains who have the Staff certificate are not required to undergo a further examination, and any included in the first two-thirds of the seniority list may be recommended.

One-third of the vacancies as Captain are to be filled by seniority and the rest by selection.

Advancement to the higher ranks from *chef-de-bataillon* upwards will be by selection, that to Colonel and General being based on the qualification list submitted by the Conseil d'Expérience de la Guerre. In the case of Lieutenants and Captains found not to be efficient for promotion, they are transferred to the reserve list on completing twenty-five years' service, and receive a proportional pension. Two years' service in the reserve reckons, under these circumstances, as one with the active army towards the final retirement and permanent pension.

Two projects for the formation of a special army for Algeria and of a reserve expeditionary corps were discussed in the Chamber in the course of the past year, one of which was brought forward by Baron Reille on the part of the Army Committee, and the other by M. Thibaudin, formerly Minister of War. Both of these were eventually withdrawn, and have been replaced by a new scheme brought in by General Campenon, the present Minister of War. It differs only from those which preceded it as regards the composition of the expeditionary corps and the conditions under which re-engagement is to be allowed.

As proposed the Army of Africa is to consist of the following troops :—

4 Rifle battalions, each of 5 companies, including 1 depôt company.
4 Zouave regiments, each of 6 battalions of 4 companies, and 2 depôt companies.
4 Algerian tirailleur regiments, each of 4 battalions of 4 companies, and 2 depôt companies.
4 African light infantry battalions, each of 4 companies, and 1 depôt company.
2 Foreign-legion regiments, each of 4 battalions of 4 companies, and 1 depôt company.
5 Disciplinary companies.
4 Chasseurs d'Afrique regiments, each of 8 squadrons.
4 Spahis regiments, each of 6 squadrons.
3 Remount companies.
4 Artillery battalions, each consisting of 1 foot, 2 mountain, and 1 horse artillery battery.

1 Pontoon detachment.
1 Laboratory detachment.
1 Artificer detachment.
4 Sapper and miner companies.
1 Escort detachment.
4 Train squadrons of 4 companies.
9 Sections of departmental troops.

The 8 Zouave battalions to be newly raised, and 4 batteries selected by the Minister of War, are to form the reserve expeditionary corps.

To carry out the propositions it will be necessary to increase the French Army by 19 infantry battalions, 8 squadrons, 16 batteries, 4 engineer companies, and 16 companies of train.

The necessity for this proposed special organization has arisen from the difficulties experienced in providing efficiently for the military requirements of Algeria, and for minor expeditions under the short service system. These difficulties have been deeply felt during the last few years, on account of the numerous enterprises undertaken by France in Tunis, Madagascar, and Tonquin. Compulsory service *per se* is sufficiently onerous where the obligation is only for military service at home, but where, as in this case, it extends to service in Algeria and expeditions to distant portions of the globe, it becomes particularly distasteful. But apart from this, France has found that it is impossible to reconcile so short a term of service with an efficient force, such as it is always necessary to maintain on a war footing in Algeria, and as is required from time to time for special enterprises, when delay is above all things to be avoided.

Our own experiences in connection with Indian and Colonial reliefs, and the frequent despatch of minor expeditions, enable us fully to appreciate the difficulties of the situation, though the duration of service with the colours in the British Army is long compared with that in France. But in other respects, the conditions of service are so different in the two armies that we cannot pass judgment upon the French scheme of meeting the difficulty from our own point of view. So far as can be foreseen, this should be a satisfactory solution for France, the colonial requirements of which are comparatively small, and where compulsory service is in force, enabling her to maintain her home establishments complete. It will in any case be a great boon to the army at large, while providing for a higher standard of efficiency abroad, if the formations can be satisfactorily completed and maintained.

A series of regulations on the subject of the duties connected with troops in time both of peace and war were issued during the year, which have been drawn up with great care, and will well repay perusal. Of these, the first is the "Règlement sur le Service dans les Places de Guerre et les Villes de Garnison," which deals with the command of garrisons, measures of security, the duties of the Governor of a fortress both before and during a siege, and all matters connected with the duties and administration of strong places both in peace and war.

The second of the series is the "Règlement sur le Service des Armées en Campagne," which embraces the organization of an army in the field; the mode of notifying orders; cantonments, bivouacks, and camps, and the duties connected with them; the supply of troops in the field; marches; measures of security and system of outposts and reconnaissance; instructions to be attended to when troops are engaged; the conduct of convoys, and the attack and defence of fortresses.

There is so much of interest contained in these volumes, and so much even in v. Löbell's review of them, that it is difficult to decide what to reproduce in a necessarily brief extract. One of the most interesting sections is, however, the extract from the second Règlement, which treats of the formation of

large bodies of troops on the march with a view to ensuring a rapid deployment into line of battle being completed in sufficient time should it become necessary. The general principles laid down are to the effect that a sufficient number of separate columns must be formed of adequate strength which shall maintain communication with each other so as to ensure mutual support. These are to be composed of the troops detailed, accompanied by the fighting train and ambulances, followed by the regimental train and convoys. The ammunition and provision wagons required on the battle-field form the fighting train; the administrative columns, artillery park, movable remount depôts, and field hospitals compose the convoys.

On the march, the fighting train follows immediately after the troops, and after it the regimental trains. The convoys move at a distance of from half a day to two days' march in rear. The columns are to be protected by advanced rear and flanking guards, according to the requirements of the situation. Apart from these, cavalry divisions will move in advance of the operating armies and obtain touch of the enemy, which is to be constantly maintained, and his movements constantly observed, while at the same time covering their own army from hostile enterprises.

The normal order of march is by divisions, and the following partition of troops is laid down :—

1. *A Cavalry Division.*

a.	Advanced Guard	1st brigade. 1 horse artillery battery (only when required for the destruction of obstacles). 1 ambulance detachment. Requisition service.
b.	Main Body	Staff of the division. 2nd brigade. 3 or 2 horse artillery batteries. 3rd brigade.
c.	Fighting train of the division.	
d.	Rear Guard	1 or 2 squadrons of the 3rd Brigade.
e.	Regimental train.	

2. *An Infantry Division.*

a.	Reconnaissance and advanced duties for the security of the division :—	The cavalry attached to it.
b.	Advanced Guard	Detachment of cavalry. 1 infantry regiment. Staff of the 1st Brigade. Half a company of engineers. 1 or 2 batteries. Ambulance detachment. Cavalry provision wagons. Camp equipment of the division.
c.	Main Body	Staff of the division. 1 battalion of the 2nd Infantry Regiment. 3 or 2 batteries. 2 battalions of the 2nd Infantry Regiment. 2nd Brigade.
d.	Fighting Train	Ambulance. Ammunition sections. Detachment of mounted police.
e.	Rear Guard	2 companies.

f. Regimental Train — Mounted police.
Train of divisional headquarters.
„ of the cavalry.
„ of the engineers.
„ of the 1st Brigade.
„ of the 2nd Brigade.
„ of the artillery.

g. Convoys with escort.

3. *An Army Corps.*

a. Reconnaissance and advanced duties—the cavalry brigade.

b. Advanced Guard — A detachment of cavalry.
1st Infantry Brigade.
Staff of the 1st Division.
Half a company of engineers of the 1st Division.
2 batteries of the 1st Division.
Ambulance detachment.
Cavalry provision wagons.
Camp equipment for the army corps.

c. Main Body .... Staff of the army corps.
Rifle battalion.
2 batteries of the 1st Division.
2nd Infantry Brigade.
Ambulances of the 1st Division.
Engineer company of the 1st Division.
Corps artillery.
Staff of the 2nd Division.
Half a company of engineers of the 2nd Division.
3rd Infantry Brigade.
4 batteries of the 2nd Division.
4th Infantry Brigade.
Ambulances of the 2nd Division.

d. Fighting Train — Engineer park.
2 infantry ammunition sections.
4 artillery ammunition sections.
Bridge equipage.
Detachment of mounted police.

e. Rear Guard .... 1 infantry battalion.

f. Regimental train.

g. Convoys, with provision columns in front.

4. *Detachment of all Arms.*

(2 squadrons, 1 infantry brigade, 2 batteries, and an engineer detachment.)

a. Reconnaissance and advanced duties, 2 squads.

b. Advanced Guard — A cavalry detachment.
2 battalions of the 1st Regiment.
Engineer detachment.
1 battery.

c. Main Body .... Staff of the brigade.
2 battalions of the 1st Regiment.
1 battery.
2nd Infantry Regiment.
Ambulance detachment.

d. Rear Guard .... 1 company.
A cavalry detachment.

e. Train.

The order prescribing the march is to contain :—Available information regarding the enemy, the directions for the march, the strength and composition of the columns, any deviations from the normal formation, the positions to be eventually occupied by the flanking guards, the station of the Commander, the allotment of cantonments, time of movement of the convoys, and where they will be halted.

The rate of march is to be regulated by the infantry, and should average 2½ miles an hour. After every fifty minutes' marching, a halt of ten minutes is to be made, when the columns will be closed up. Prolonged halts are only to be made if rendered necessary by the heat of the weather or the length of the march.

The review of the new Règlements is followed by an exhaustive account of the recruiting operations, the result of which for 1883 was a contingent of 105,961 men of the 1st category, and 31,039 of the 2nd, or in all a total of 137,000, being 3,864 in excess of the preceding year. These were allotted to the several arms and departments in the following proportion :—

	1st Category.	2nd Category.	Total.
Line regiments	63,808	16,828	80,636
Rifle battalions	5,172	581	5,753
Zouave regiments	1,747	....	1,747
Algerian Tirailleurs	300	....	300
African Light Infantry	3	....	3
Paris Sapeurs-Pompiers	30	....	30
Foreign legion	2	....	2
Total	71,062	17,409	88,471

Cavalry—1st Category only.

Cuirassiers	2,067
Dragoons	4,595
Chasseurs	3,581
Chasseurs d'Afrique	710
Hussars	2,109
5 Remount companies	6
Cavalry schools	3
Total	13,071

	1st Category.	2nd Category.	Total.
Artillery—			
Artillery regiments	9,886	6,722	16,608
Pontonniers	747	....	747
Foot Artillery battalions	2,681	2,915	5,596
Artificers and laboratory companies	111	....	111
Total	13,425	9,637	23,062
Engineers—			
Engineer regiments	2,365	126	2,491
Railway companies	80	....	80
Total	2,445	126	2,571
Train	2,322	3,148	5,470
Administrative branches	3,576	719	4,295

The new law for the administration of the Army, which came into force in 1882, had for its result the placing of the departments under the direct control of the Military Commander. This radical change in the previously existing system necessitated the issue of new instructions regarding the authority and the duties of the Intendance Officers. These have accordingly been embodied under four heads, treating of the duties connected with supply, clothing, equipment, transport, camp equipage, the payment of the troops, the supply of material, and provisions for the hospitals and ambulances, together with other subsidiary financial services.

In time of peace the entire duties of the Intendance in an Army Corps or a Military Government are conducted by the Intendant-General or the Military Intendant, as the case may be; but in war time the Army Intendant can act only under the authority of the Commander-in-Chief.

Considerable progress has been made in the appointment of Officers, with a view to completing the proposed establishment of the Active Army, as well as of the Reserve and Territorial Army. Including the whole of Officers and officials ranking as such, the Intendance numbered at the end of the year as many as 3,763, being 300 more than in the previous year, but the establishment has not yet been reached.

The Control Corps instituted in 1882 in connection with the new Law of Administration has now been formed, and 22 fresh appointments made to it, of which 17 were superior officials of the Intendance, and 5 were taken from the combatant arms. The total number was thus raised to 43. They commenced their duties in the autumn by the inspection of the administrative establishments and services in the several garrisons.

As regards the corps of Officers in the infantry, the situation cannot by any means be regarded as satisfactory. Promotion in the higher grades above the rank of Captain is very slow, and has given rise to a spirit of dissatisfaction, which can hardly be wondered at, when Captains have to serve from 13 to 14 years in that rank before obtaining their promotion. The reason is not far to seek, for in the French Army there are only 7 Field Officers to 24 Captains per infantry regiment, so that in time of peace the ordinary tour of promotion holds out little prospect of advancement to the higher ranks. Both the Active Army and the Reserve showed a deficiency, principally of Lieutenants, and the decrease in the number belonging to the Reserve was 827 more than in the preceding year.

Revised regulations were issued provisionally last year for the organization of the Medical Services in the field. According to the instructions contained in these the several establishments are to be distributed in three lines. Of these the first comprises the dressing stations and ambulances for the use of the troops on the march, and for the first dressing of the wounded on the field. The second line is composed of the movable and stationary field hospitals and convalescent depôts for the reception of such of the sick as may be expected to be able to rejoin in a few days. In the third line are included the ambulances and wagons allotted to the evacuation of the sick and wounded to the rear, and also the trains fitted up specially for the purpose of completing this movement.

The whole of the services are under a Médecin-Inspecteur, who has immediate control over the entire military and civilian *personnel* employed with the ambulances and hospitals. To enable him to enforce his authority, disciplinary powers similar to those of a Brigadier-General are delegated to him. He is responsible for the establishment and removal of the several hospitals, as well as for all their interior arrangements, and he has to report every five days, and after any engagement, to the General Commanding upon the state of the sick and wounded. Special attention is enjoined to the timely and rapid evacuation of the wounded from the hospitals in second line, with a view to which the Médecin-Inspecteur is to be in

constant communication with the Director of Railways through the General Officer.

The medical services of each Army Corps are, as in time of peace, under a Director, who superintends them and directs the establishment of the ambulances and convalescent depôts, applies for or requisitions the necessary wagons for the transport of the wounded, and is responsible to the General Officer Commanding for taking such measures and giving such orders as are best calculated to ensure the satisfactory sanitary condition of the troops. Each division has a Divisional Surgeon, who regulates its medical services, and takes his orders from the General commanding it as to the establishment of the ambulances, the duties of which are provided for by the Medical Officers belonging to the second line.

The immediate service with the troops is performed by the Medical Officers, sick-attendants, and bearers allotted to them, of whom the latter only come under the doctors' orders whilst actually employed in their duties of removing the wounded from the field. Dressing stations are arranged by battalions or regiments, as the circumstances may require, at the commencement of an action. They are established in a line with the reserves, and care is to be taken that they are never placed in the vicinity of important tactical positions. From these the wounded are sent back with as little delay as possible to the ambulances.

The movable field hospitals to be employed, and their position, are designated by the Director of the Medical Service, under the orders of the General Commanding.

Ambulances are established at the several etappen stations for the reception of those sent back until they can be forwarded to the rear. Provisional ambulances are also to be provided at the more important railway stations, where men unable to continue their journey may be received and treated. The duties in connection with these, as well as those of the special hospital trains, may be provided for by the "Société de Secours aux blessés Militaires."

The disciplinary powers of a Regimental Commander are given to the Medical Officers in charge of hospitals and ambulances, both in regard to their *personnel* and the patients under treatment.

New regulations have also been introduced for the selection and training of the sick-attendants and bearers. In every company, squadron, and battery, one man is to be borne in excess of the establishment as a sick-attendant; and of these one in each battalion or group of batteries is to be a corporal or sergeant. In addition to these, four men in each company or battery are to be trained as bearers. Every year when the oldest class is passed to the Reserve, four men are to be selected from amongst them per infantry and artillery regiment, and two per cavalry regiment and foot artillery battalion, for service as sick-attendants if called up. Those not previously trained as such have to be put through a two months' course of instruction.

The bearers for the infantry and artillery reserve are to be taken from amongst the musicians and artificers, and there are besides those men who are passed to the Reserve in regular course and have been previously trained as sick-attendants. In the cavalry those men are to be selected who show the least proficiency in riding.

The law introduced in July, 1881, with a view to bettering the position of the non-commissioned officers, and inducing more of them to re-engage and continue with the colours, has not had the desired results. Other proposals have now been made, by which they may be permitted to receive a modified pension after 12 instead of after 15 years' service, as before, and the period of re-engagement is reduced to one, two, or three years, at the man's option. After three years' ordinary service, and nine on re-engagement, the non-commissioned officer can claim a pension for life and a civil

appointment. The pecuniary conditions of re-engagement are the same as under the former law, except that those extending their service for one year only are to receive an increase in daily pay in lieu of a bounty.

The *Spectateur* does not anticipate any more favourable results from the new law, and believes that the only method of obtaining and keeping good non-commissioned officers is by giving civilian appointments only to non-commissioned officers who have served at least four years. By the above the pensioned non-commissioned officers remain at the disposal of the War Minister for five years after leaving the Army, and may be employed for the manœuvres.

Considerable progress has been made in the development of the Territorial Army, and the number of its Officers materially increased. In the higher ranks in the infantry, which forms the bulk of the territorial formations, there were wanting only two Lieutenant-Colonels and eighteen Chefs de Bataillon to complete the establishment. A proportion of the Army, viz., 5,033 Officers and 141,412 men, were called up for manœuvres in three series of twelve days each, the result of which was reported to be very satisfactory.

A great extension has been given to military exercises in schools, to which a high importance is attached, as calculated to give a martial bent to the youth of France. Battalions are regularly formed, the arms and equipment being provided by the State. As might be expected, Paris has taken the lead in these formations, mustering twenty-four battalions of four companies.

Austria.

The year has not been marked in the dual Empire by any important changes, though some existing laws have been consolidated or modified. The General Staff, for instance, was reorganized in 1875, and made into a separate corps, which was a return to the practice in force prior to 1871. This organization has now been confirmed by the issue of revised regulations on the same lines.

The General Staff as so constituted consists of the following Officers :—

1. Those belonging to the permanent General Staff Corps, the lowest rank in which is Captain of the 1st class.
2. Those attached on probation.
3. Those detached temporarily from the troops, and borne as supernumeraries.

At its head is a General Officer of standing, superintending all arms and branches, and directly responsible to the Emperor. Notwithstanding this he works in concert with the Minister of War, to whom all important organic propositions have to be addressed. He has to deal with all war preparations and military questions—the ordre de bataille, mobilization, defensive works, railways and communications ; questions of organization, armament, equipment, and manœuvres ; and he is especially responsible for the interior working and completion of the General Staff Corps. A Chief of the Staff is also appointed to each army corps, division, and brigade.

The General Staff Corps is recruited from Officers of the Army possessed of the necessary scientific qualifications, and tested in the military duties required. With this view all Officers are attached on probation prior to final appointment to the corps. Before being so attached, however, they must give satisfactory proof of qualification as follows :—

1. They must have completed three years' service, and be certified to be in all respects good regimental Officers.
2. They must produce a certificate of good moral character.
3. Give proof of a good sound general education.

4. Give proof of sufficient technical knowledge, such as is required for the higher certificate at the final examination at the high military schools.

5. Satisfy requirements as to physical qualifications.

Appointment to the corps on completion of the term of probation rests exclusively with the Chief of the General Staff.

The previously existing "field-railway divisions" have been replaced by a combined "railway and telegraph regiment," and the generally extended technical duties now comprised within the duties of the Engineers render a short review of the several services desirable. By the revised instructions their duties embrace the following subjects :—

1. The technical works and fortifications of the theatre of war.
2. The repair or destruction of roads and bridges.
3. Participation in the construction and destruction of railways.
4. The intrenchment of positions and battle-fields.
5. Participation in the attack and defence of intrenched positions and localities ; breaking down the enemy's obstacles and defensive arrangements, and strengthening works or positions which have been captured.
6. The construction of trench and mining works in connection with the investment, siege, or defence of fortified places, and the manipulation of everything connected with the mining operations.

The engineer troops are organized in 2 regiments, each of 5 active battalions of 4 field companies, besides 2 reserve companies and 1 depôt battalion of 5 companies. In peace the latter are composed only of cadres stationed at the regimental headquarters at Olmütz and Krems, viz., 1 company cadre per detached battalion. To the regiments are attached 15 columns of *matériel* and the Engineer park, which carry intrenching tools and the necessary implements, explosives, surveying instruments, &c. Each column is composed of seven four-horse wagons. There are also the siege park and reserve engineer park.

Only a proportion of these formations are attached to armies and army corps in the field, the remainder being distributed in the garrisons and fortresses. For technical and administrative purposes they are under the Ministry of War, but are under the direct control of the General Officer Commanding in all military matters.

The strength of a field or reserve company on a war footing is 5 Officers, 235 men, 26 draft and 2 riding horses ; of an Ersatz company 5 Officers and 230 men, and of a column of intrenching tools 22 men and 28 horses.

In close relation to the engineers is the Pioneer regiment. The principal duties which fall to the lot of this formation are as follows :—

1. The construction of military bridges by means of its bridge equipage and train, and the arrangement of flying and semi-permanent bridges.
2. The arrangements for and the management of the crossing of rivers by troops in boats, whether in those belonging to the bridge equipages or in others.
3. The repair and destruction of roads and ways ; participation in the construction or destruction of railways or bridges.
4. Participation in intrenching positions and battle-fields.
5. The construction of the more important technical works in camp and on the march.
6. The manipulation of waterworks in connection with the above.

Each army and army-corps has a proportion of pioneer troops attached to it for these services, and the remainder which are not occupied in this manner are employed in the fortresses and on the lines of communications. Where works on a large scale are undertaken, and the pioneers are employed in concert with the engineers, the senior Officer of the latter superintends the works of fortification and the mines, while the pioneer Officer takes charge of the bridging and water transport arrangements.

The pioneer regiment consists of 5 field battalions of 4 companies, 1 reserve company, and 1 reserve park.

To each battalion are allotted 8 bridge equipages, which are taken charge of by the reserve park. Besides these there are 16 more for the equipment of the reserve companies, which are ultimately destined to strengthen or complete the formations with the operating armies. The bridge equipages are ordinarily retained with the army reserve formations, and are only detached to the several army corps or pioneer companies when specially required; or they are collected at those points where they are likely to be utilized.

Each equipage comprises stores, tools, and the necessary material for the construction of about 90 yards length of bridge on a fixed or floating foundation.

Light bridge trains are also carried in the proportion of one to each army corps, and attached to its pioneer company. These are made use of by the advanced guard for spanning lesser obstacles, such as canals, streams, dykes, or hollow ways, and provide for a span of about 14 yards.

The pioneer regiment is placed under the Chief of the Staff for military and technical purposes, but the several units come directly under the command of the Officer commanding the troops to which they are attached. In time of peace the regimental Staff, 1 battalion, and the tool depôt are located at Klosternenburg, and 1 battalion is at Pressburg, Prague, Linz, and Pettau. The war strength of a field or reserve company is 5 Officers, 217 men; of an Ersatz company 4 Officers and 223 men; of the first four tool reserves 2 Officers, 51 men; of the fifth 2 Officers and 63 men; of the tool depôt 5 Officers and 174 men, and of a movable tool depôt 2 Officers and 35 men. Altogether the establishment of the regiment, together with the tool depôt, amounts to 181 Officers, 7,092 men, and 676 horses. The train connected with it numbers in addition 287 drivers, 164 riding horses, 510 draught horses, and 105 wagons.

The transport of the bridge equipages is provided for by the train squadrons Nos. 65 to 75, two being allotted to the 8 equipages of each pioneer battalion, and No. 75 providing for the reserve equipages. As each of the train squadrons is capable of subdivision into 4 sections, this gives 1 section to each bridge equipage.

The "Railway and Telegraph Regiment" was formed last year from the 6 reserve companies of the 2 engineer regiments, and the 5 previously existing railway divisions. A portion of the newly constituted regiment is trained and equipped with especial reference to railway work and the remainder has for its sphere the construction and manipulation of the field telegraphs.

The duties of the railway companies in the field are as follows: 1, the restoration of damaged lines; 2, to assist in laying down new ones; 3, the provisional management of lines occupied in the enemy's country, of those restored by them, or of newly laid lines; 4, the destruction or obstruction of railways.

The field telegraph formations have the following to attend to: 1, the restoration and management of the telegraph lines within the sphere of operations, or their destruction when necessary; 2, the laying down of semi-permanent lines in connection with the permanent lines, and working them; 3, their destruction when required.

In peace time the regiment is composed of 2 battalions, each of 4 companies, and a depôt cadre. On mobilization this battalion organization is broken up, and the regiment furnishes the following formations:—

1. 8 railway companies, each of 4 sections, so constituted and equipped as to be capable of employment independently.
2. 3 field telegraph directions for the first line.
3. 3 field telegraph directions for the second line.

4. 43 field telegraph and 3 mountain telegraph subdivisions.
5. 1 Ersatz battalion of 2 Ersatz companies.

The method of effecting these several formations is by extending the companies of the regiment in the following manner: From each is formed 1 railway company, and from Nos. 1 to 7 companies also 6 field telegraph subdivisions each, and from the 8th company the 43rd subdivision and the 3 mountain telegraph formations.

The regiment is placed under the Chief of the General Staff, but the several portions attached to troops are under the immediate orders of the Officer in chief command of them.

The organization of the Landwehr in Austria continues to be the same as for some years past. But until last year attention was paid only to the formation of the infantry, which constitutes the bulk of the forces, and numbers 82 battalions, 82 reserve battalions, and 82 Ersatz companies, besides 10 rifle and 10 reserve battalions in the Tyrol and Vorarlberg. Last year, however, a commencement was made with the cavalry formations, which are to consist of 3 dragoon and 3 lancer regiments, each of which is to be divided into 4 field squadrons and 1 Ersatz subdivision.

Cadres only are to be maintained in time of peace, consisting of 1 Captain, 3 Subalterns, 1 Cadet, 52 non-commissioned officers and men, and 66 horses, also an administrative Officer, a corporal as clerk, and an armourer. Those for 2 dragoon regiments have been established, No. 1 at Stockerau in Lower Austria, and No. 2 at Prosswitz, in Moravia, and the lancer regiment No. 3 at Sambor, in Gallicia.

Horses for the full war strength, and 6 per cent. over to meet casualties, are bought, and, after breaking in, are handed over to private individuals under a special contract. By the conditions of this they are to be mustered twice in the year, when fines are inflicted if the horses do not come up in proper condition, and premiums are given for those particularly well kept. At the end of six years they belong unconditionally to the contractor. Each cadre receives yearly 112 remounts to train to take the place of those given over.

Both dragoons and hussars are armed with swords and breech-loading carbines. Five men are trained as pioneers in each squadron.

Roumania.

The Roumanian Army was reorganized by a new law, dated June, 1882, which began to take effect the following year. The peculiar institution of permanent and semi-permanent troops has been retained in the active army for the same reason that it was first adopted, which was the necessity for combining a considerable force with strict economy in the military budget. The length of service, however, of the first category is only a year, while the second receive only an interrupted training.

The whole army is now localized and divided into active army, militia—forming a reserve army—and landsturm. The semi-permanent portion of the first of these is only of infantry, termed "Dorobanz," and cavalry, "Kalarasch," and they are employed on customs duties on the frontier and as gendarmerie respectively. The basis of the territorial organization is the regimental district, which corresponds with the administrative one.

The divisional organization previously existing has been replaced by that of army corps, of which there are four, each composed of 2 divisions of 2 brigades. The staff of these corps were formed last year at Krajova, Bucharest, Galatz, and Jassy. They are each composed as follows:—

Permanent troops	....	2 infantry regiments.
		1 rifle battalion.
		2 artillery regiments.

Permanent troops	....	1 cavalry regiment (except in 4th army corps).
		1 train squadron.
		1 sanitary company.
Semi-permanent troop	....	8 Dorobanz regiments.
		3 Kalarasch regiments.

The result, therefore, of this new organization is that Roumania has an active army consisting of :—

8 infantry regiments of 2 battalions	85 battalions infantry.
4 rifle battalions	
32 Dorobanz regiments of 2 battalions (one of 3 battalions)	
3 cavalry regiments of 4 squadrons	57 squadrons cavalry.
12 Kalarasch ,, of from 3 to 4 squadrons	
8 artillery regiments of 6 batteries	48 batteries artillery.
1 engineer regiment of 2 battalions of 5 companies	10 companies engineers.

Besides which there are the following special and departmental troops :—

2 companies and 2 squadrons military police.
4 squadrons of trains.
4 companies of sanitary troops.
4 companies of artificers and tradesmen.

In time of peace the active army numbers from 25,000, after the dismissal of the reserves, to 70,000 during the autumn manœuvres. Generally speaking it may be estimated at about 35,000 men, with 192 guns, of which 2 per battery are not horsed.

On a war strength it numbers 103,890 combatants, made up as follows :—

Infantry	....	85,000.
Cavalry	....	8,550, all mounted.
Artillery	....	7,840 men.
		5,380 horses.
		294 guns.
Engineers	....	2,500.

making a grand total with departmental troops of 120,000 men.

Each of the 4 army corps has a strength of 25,000 combatants and 72 guns.

There can be no doubt that the above numbers would be forthcoming for an operating army, for there are 320,000 trained men liable to military service. Taking the 8 youngest classes, which used formerly to be 24,000, but are now increased to 32,000, they should give, after allowing for waste, at least 200,000, which would give a balance of 80,000, for the formation of the Ersatz troops, viz. :—

39 battalions,
15 squadrons,
8 batteries,
2 companies engineers,

which with the necessary train formations would not amount to more than 45,000 men.

So far, therefore, as the men are concerned, Roumania has at her disposal a very respectable force, the material of which proved its value in the campaigns against Turkey when fighting as Russia's ally. The present condition though of the army is in several respects far from satisfactory. These are the weak effective of Officers, the condition of the horses for the active combatant formations, and the defective equipment of the train. The existing

companies, squadrons, and batteries have, for the most part, only one Officer besides their commander, and on mobilization, after calling up those on the reserve list, would be 50 per cent. short. The want of horses and the bad condition of those available prevents the proper training of cavalry and artillery, and would render them comparatively useless when wanted. The formation and equipment of the train has been neglected, and could not be adequately supplied by requisition.

Roumania could not as yet think of forming a reserve army from the militia. The men are forthcoming in sufficient numbers, and there are good arms available, but Officers are altogether wanting. At the best, in case of emergency, more could hardly be done than to form 1 battalion, 1 squadron, and 1 battery in each of the thirty-two districts, which would amount to some 40,000 men, and to officer them by means of old retired Officers. They might then be found of some use in supplying garrisons for the fortresses, and to assist in defence of the frontier.

The formation of a National Guard in the towns from the landsturm and the shooting associations, which have lately come into existence, can only be of military value in so far as, being armed by the State, they might be utilized for service in the interior, and thus release troops of the reserve or field army.

The rearmament of the field artillery with Krupp guns and Armstrongs, for mountain batteries, and of the infantry with the Martini-Henry rifle, is being pushed on.

So far as the defensive is concerned we may certainly regard Roumania as adequately provided for all probable eventualities; but the military capabilities of her army for operations in the field are greatly reduced by the defects already noticed. Of these perhaps the most serious is that regarding the Officers, for a properly qualified corps of Officers is not to be improvised, but must take many years to create.

Russia.

The report on the Russian Army is not confined to the changes effected last year, which, with the exception of those in the cavalry, have not been important; but contains an exhaustive account of the general organization of the army. The subject, including the augmentation of the cavalry last year, has been so fully treated by Sir Lumley Graham in this Journal,[1] that it is unnecessary to do more than remark upon the minor changes which have been effected since his papers were published.

The engineer formations have been augmented by the addition of 3 sapper battalions, 2 engineer field parks, and 8 military telegraph parks, together with 1 sapper company in West Siberia. This brings the total of these up to 13 sapper battalions, 6 engineer field parks, including one in the Caucasus, and 16 military telegraph parks, including one in the Caucasus.

The Army of the Caucasus was increased in November of last year by 6 infantry reserve battalions, and 6 reserve battalion cadres were formed in Western Siberia, making, with the guard reserve battalion cadre and the 96 reserve battalion cadres already existing, a total of 109 reserve battalion cadres, each of 5 companies. On mobilization these companies are formed into a battalion by the incorporation of the reserve men, and four of these form a reserve regiment, the fifth being independent. No regular train material has as yet been adopted for these regiments, and all the necessary wagons and horses for it would have to be bought.

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[1] "The Russian Army in 1882," in Nos. CXIX, CXX, CXXI, and CXXV of this Journal, by Colonel Sir Lumley Graham, Bart.

The incorporation of native levies into irregular troops continues its course, and the following formations were created in 1883 as a sort of standing militia :—

1	Kuban	mounted sotnia.
3	Terek	„ „
3	Daghestan	„ „
3	Kars	„ „
1	Batum	„ „
2	„	foot „

also a Kutais irregular mounted division of 2 sotnias.

By a law issued in March, 1883, the administration of military law has undergone a complete transformation. The principal features of the new code are as follows :—

1. Regimental courts are established for each regiment, artillery brigade, and all other corps of which the commander has a like status. The president is one of the battalion commanders, a junior field Officer, or one of the senior battery Officers. There are 2 members, being company or squadron commanders, or battery Officers of at least 4 years' service. The president and members are nominated by the commander of the troops, the former for the term of 1 year, the latter for 6 months, with the condition that one of them is changed every 3 months ; they continue to perform their regimental duty. The divisional Commander is the confirming Officer of these courts. Corps which have no regularly constituted regimental court have their cases disposed of by the nearest one available under the orders of the General commanding the district.

2. A district court is established in every military district, composed of a permanent president and a certain fixed number of permanent military judges, together with other members who are appointed for a term of 4 months only. These latter are appointed by the General Commanding from amongst the duly qualified Officers as follows :—2 field Officers, who must be battalion commanders, or junior field Officers who have commanded a company for at least 2 years, and 2 company or squadron commanders of at least 4 years' service, of which 2 shall have been in command of a subdivision. Every 2 months one of each of these ranks is changed on completion of their 4 months' tour, and they are not to be detailed again till after a period of 2 years.

3. Provisional military courts may be convened by the Commanders of districts to dispose of cases in garrisons situated at a distance from the place where the district court holds its sittings. They are usually assembled three times in the year, but in addition to these regular occasions it is at the discretion of the General Officer Commanding to order their assembly at any time to try specially important cases of offences against discipline demanding an immediate example. They are composed of a permanent president chosen by the president of the district court from amongst its permanent members, and 4 members appointed for a limited term from the same classes of Officers as those serving on the district court.

4. The Supreme Military Court acts as a Court of Cassation, and is formed of a President and 5 permanent and other members, of whom 2 must be General Officers. Those appointed for a term only are changed after 6 months, in such a manner that one is replaced every 3 months. They are not as a rule to be again detailed under a period of 3 years.

In cases of special importance the General Officer commanding the district can convene a special court to hear the appeals of the prosecutor, or of the defendant against the decisions of the District or Provisional Courts. For this purpose the 2 senior permanent members of the District Court, and 2 Generals or Field Officers holding commands, are assembled, and their

judgment upon the case before them has equal weight with that of the Supreme Court.

Only those Officers who have qualified in military law at the special academy for that subject are appointed to be Presidents of the District Courts, Military Judges, Judges of Appeal, and Advocates. All those so qualified are further attached, upon leaving the academy, to a District Court for a year.

The proceedings of the several courts are conducted verbally, and are open except in most unusual cases. The advocate of the district is present throughout, excepting during the deliberation and verdict. The Regimental Courts deal with the offences of non-commissioned officers and men which cannot be summarily dealt with, which entail fine up to the amount of 23*l.*, and corporal punishment up to 200 lashes with the knout. The District and Provisional Courts have jurisdiction over Officers and officials, and deal also with the cases of non-commissioned officers and men whose offences entail a heavier punishment than can be inflicted by the Regimental Court. The Supreme Court has the power to confirm, quash, or alter the decisions of the inferior courts, and it decides also disputed questions of law.

Servia.

By a new military law introduced last year, every Servian citizen is bound to serve personally, and his obligation, which begins on attaining 20 years of age, does not cease until the age of 50. The armed forces are comprised under three categories, viz., the active army, in which service is for 10 years, the reserve army 7 years, and the landsturm 13 years.

The active army comprises permanent troops and reserve, and is formed into 5 territorial divisions comprised of the following troops:—

Infantry, 15 regiments of 4 battalions.
Cavalry, 5 regiments of 4 squads.
Artillery, 5 regiments of 8 batteries of 6 guns.
Pioneers, 5 companies.

In addition to these divisional troops there are—

1 guard squadron.
1 mountain artillery regiment of 6 batteries of 4 guns.
1 garrison artillery battalion of 4 companies.
1 mining company.
1 railway company.
1 reserve sanitary company.
2 telegraph sections.

The reserve army is formed similarly into 5 divisions composed of the same formations.

The landsturm is composed of infantry alone, of which 1 battalion is formed by each battalion district, 60 in number.

In all, therefore, the Servian Army should number 180 battalions, 31 squadrons, and 66 batteries. The permanent troops of the active army are, however, the only force regularly maintained in time of peace, and these are on a very weak establishment, as follows:—

Infantry, 15 battalions of 4 companies of 186 of all ranks.
Cavalry, 6 squadrons of 176 of all ranks.
Artillery, 20 batteries of 82 of all ranks.
Mountain artillery, 3 batteries of 56 of all ranks.

Besides the several technical and administrative services. In all, the per-

manent portion numbers about 17,000 men, of whom 220 are the staff of army commands and territorial divisions. Of these, 11,300 are infantry, and 900 cavalry, with 144 guns.

On mobilization an active army of 70,000 men is formed, with 288 guns, as follows:—Each company of the permanent cadre forms an active battalion and an Ersatz company, and each battalion forms an infantry regiment and an Ersatz battalion. Of the cavalry each of the squadrons from 1 to 5 forms an active cavalry regiment of 4 squadrons and 1 Ersatz squadron. In the artillery each of the existing 23 batteries and 2 companies is doubled.

The men of the 5 pioneer companies go to form mining, telegraph, and railway companies according to their qualifications. The remainder of each company cadre forms 1 active company, 1 engineer depôt, and 1 Ersatz pioneer section. The 2 pontoon companies form 5 bridge half sections, 1 bridge train, and 5 Ersatz pontoon sections.

Infantry Tactics.

Last year did not afford any practical experience for infantry in the field, except in connection with French colonial enterprises, which were on a small scale, and in connection with which no fighting to speak of took place. There has notwithstanding been no lack of activity displayed in the training and perfecting the infantry soldier at home. Every European army has continued to work steadily with this view, though unostentatiously and principally at matters of detail which have not attracted particular remark. For many years subsequent to the close of the Franco-German War, attention was directed almost exclusively to the investigation of tactical formations, with a view to adopting such as should appear most suitable for attack and defence under the new conditions entailed by the general introduction of the breech-loading rifle.

This question, if not definitely settled, has at least been indefinitely postponed, while in its place has sprung up the endeavour to still further perfect the infantry arm, and ensure the soldier using it with the best results. This during 1883 usurped the foremost place in practice and in military literature.

As applied to the German Army the subject has been divided under two heads, the first being whether it is advisable to replace the present arm by a magazine rifle, and the second as to whether the sighting arrangements are not susceptible of improvement.

Considered from a tactical point of view there are many objections to the general adoption of the magazine arm, even supposing it to be possible to obtain one which would fulfil every favourable condition of an arm for war purposes. The repeater, for instance, weighs about 1 lb. more than the ordinary rifle, and it does not appear how it can be possible to materially diminish this extra weight while maintaining the efficiency of the arm. The more rapid shooting, which is the principal advantage claimed for it, is not by any means free from drawbacks. With the increased facility and rapidity of firing the excitement of the soldier increases also, whereas the chief difficulty at all times when engaged is to keep him cool and induce him to fire steadily. Another important factor is the smoke, which often plays a kindly part to one side or the other of engaged troops by obscuring the view of their opponents, and which must necessarily be increased enormously with the magazine rifle, unless a smokeless powder can be substituted for that in ordinary use.

But even the rapidity of fire claimed as its undeniable advantage has its limits, and will forbid the general employment of the magazine, for it would not be possible to keep the troops supplied with the largely increased amount of ammunition which would then be necessary. For special moments, no

doubt, an attachable magazine may be of the utmost value, but it will be hardly possible, even with the best trained troops, to prevent their firing it away at the wrong time. The replenishment of it in action is hardly practicable ; at least, it would demand a coolness on the part of the men in face of the enemy which can by no means be counted upon.

In short, v. Löbell comes to the conclusion that the possession of the magazine rifle in itself is not calculated to give any paramount tactical superiority, and certainly does not offer any such decisive importance as did the introduction of the breech-loader.

Notwithstanding this and the expense which would be entailed, as well as the inconvenience and difficulties in the way of changing the arm throughout the army, if any other Power should adopt it, Germany must follow suit. At a time of general arming and of large armies, the moral factor must not be disregarded so far as to allow the chance to arise of meeting a better armed opponent in the field.

The general introduction of what is ordinarily called field-firing as a part of the regular instruction of the soldier has led to many interesting experiments, of which those made at the Belgian School of Musketry are of especial value. From the results of these certain deductions were drawn which may be briefly summarized as follows :—

1. At a range of 650 yards the difference between the losses of infantry in line and company columns are immaterial.

2. At from 1,300 to 1,750 yards the losses in company column formation are about a quarter greater than in line, but this proportion does not increase with the distance.

3. When troops are lying down their losses in either formation are about a half.

4. At from 650 to 1,750 yards the losses in a line formation standing up are almost identical with those of a column lying down.

5. Individual fire gives better results than volleys.

6. Against cavalry 4 volleys can be fired in the 53 seconds of time required by it to close from 550 to 100 yards distance. In this practice 60 men firing 4 volleys (240 shots) hit 38 cavalry figures.

As a practical result it is advocated that on the approach of cavalry bayonets should be fixed, and fire reserved until they arrive within 450 yards. The first volley should then be fired, sighting for 350 yards, followed by two others, after which the troops attacked prepare to receive cavalry.

The results of the firing in squares are not given, for apart from the reduced number of rifles which can be brought to bear in this formation, there are other serious disadvantages connected with it. In any case, armed with the present rifle, infantry which cannot repel cavalry successfully without forming square deserve to be ridden down. The firing at long distances, which for a time was much in vogue in the German Army, has been discontinued.

In France the Drill Regulations of 1875 have been extensively revised. The careful search for cover by the advanced line of attack formerly inculcated is now forbidden, and it is pointed out that the immediate object of the attack is to come to terms with the enemy, and to break his resistance at whatever sacrifice may be necessary. A brave and energetically led infantry, it is added, can advance against well-defended intrenchments under the heaviest fire, and carry them. The instructor must not omit to teach the men how to utilize the varying formations of ground ; but in doing so he should impress on them never to seek cover which will impede the use of their arms and prevent a rapid advance.

In connection with this a new attack formation is introduced, which varies according as the company is acting independently or forms part of a larger unit. In the former case, one section only, normally the first, forms the extended line, supported at a distance of 220 yards by a second section, the

other half company in column of sections forming the main body at an interval of 280 yards. This is an approximation, if not a copy, of the German system as approved in 1876, and which has not been without its advocates for introduction into the British service. But before this could be done with any advantage, the Continental system of fewer and larger companies would have to be adopted, which there does not seem to be any prospect of, at present at least.

When the whole battalion is employed for attack, whether independently or as a portion of a larger body of troops, the formation is different. The two leading companies then form the extended line and the supports, the remaining two companies serving as reserves. Each of the advanced companies has two of its sections, normally the first and third, in the extended line, and the remaining two are formed in line, with intervals, at a distance from it of 220 yards, as supports. The two companies in reserve follow in line of half-company columns of sections, with intervals of 33 yards between them, 330 yards in rear.

This differs from the German system, in which the two advanced companies are formed as if acting independently, and approximates very closely to the Russian method introduced two years previously. In the latter, however, the reserve companies are formed normally in company columns, and there is an interval of 415 yards between the extended line and its supports.

The battalion always forms for attack from line of half-company columns. Fire is not opened until the advanced line arrives within 600 yards—in open ground not so soon—and the advance is then effected by means of alternate rushes. The supports gradually close on the extended line, and are moved up to it when it is unable to advance any further without assistance, generally at about 440 yards. During the further advance the companies in the front line close in towards their centre, to allow of the reserves moving up. This follows the German regulations, which, while leaving a great deal to individual discretion, lays down that the troops in the extended line, after being reinforced, must close while advancing in such a manner as to admit of the reinforcing bodies being moved up into it without being broken up.

One reserve company follows 110 yards in rear of the centre, and eventually fills up the interval thus created between the inner flanks of the two advanced companies; the other follows at 220 yards from the extended line. Both of them are advanced as far as can judiciously be done in close order, and at least in sections.

The further advance is carried out rapidly by alternate companies up to 280 to 220 yards distance from the enemy's position, when bayonets are fixed and independent fire opened. If this fire should not of itself prove decisive, the remaining reserve company is brought up in close formation, to give a fresh impulse, and the whole storm the position, supported by the troops in second line.

In comparing the revised regulations with those that preceded them, it is noticeable that a far more energetic interpretation is given to the offensive. Firing at long ranges is limited; the continuous reinforcement of the extended line, and the complete utilization of the reserves to that end, is provided for in such a way as must exercise a material influence on the forward movement; but, above all, the former excessive depth of the battalion in its formation for attack is diminished by a half, and the conduct of the attack lightened in the same proportion that its power is increased.

Interesting parallel tables are attached to this particular portion of the "Berichte," showing the several methods of infantry drill and attack formations as they exist at present in the greater European armies, into all of which new regulations have been introduced more suited to the requirements of the actual organization and improved arms during the last eight years. A comparative study of these cannot fail to be of interest, and it will be found that

in the more important portions, such as the formations for and the methods of carrying out the attack, whether as independent companies or as part of a larger body, the principles adopted are generally identical with those first introduced by Germany, and in many cases approach it nearly in the details of execution.

It is somewhat remarkable, therefore, that both Austria, in her amended regulations of 1880, and Russia, in those introduced a year later, should both have adopted the system of reinforcement by mixing up the supports with the already extended line. There can, one would have supposed, be only one opinion as to the merit of this compared with that adopted by other countries, of bringing up the supports, in comparatively close order, into the gaps formed with that view by closing in during the advance. All experience would seem to point to the superiority of the latter method, which has now been introduced into the British Army, and it is certainly a subject for surprise that it has not been more generally adopted.

Cavalry Tactics.

There have not been any considerable changes in cavalry tactics during the past few years. On the other hand, the increased importance of that arm for strategic purposes has been acknowledged, and has led to the special training of cavalry with a view of fitting it for these more thoroughly. This is the natural consequence of the further development of the independent employment of cavalry in advance of armies operating in the field, first resorted to by Germany in her late campaigns. The value of such a system was then fully proved by experience, and adopted, in theory at least, by other armies. But few went beyond this, or attempted to put it into practice by the special training of large bodies of cavalry.

Such armies as did so indeed restricted their exercises to collecting together for a brief period a few regiments, or perhaps a Division of cavalry, and working against an imaginary enemy. These exercises have their value, and are not to be discouraged; but it is hardly necessary to say that they can in no way be compared with real warfare, in which a more or less enterprising enemy has to be considered. This came to be recognized a year or two ago, when France and Austria both held special manœuvres, in which large bodies of cavalry were opposed to one another. Other nations have since done the same; but only as exceptional exercises beyond the general scheme of training, and more for the instruction of General and Staff Officers than as a practical training for the troops.

Russia alone of all the military Powers appears to have grasped the fact that it is not sufficient to incorporate together on the outbreak of war a number of cavalry regiments armed and trained in the ordinary manner, and then to expect from a corps so formed the arduous services demanded from cavalry acting by itself, at a distance from the army to which it belongs. This may probably be owing to the circumstance that Russia has at her disposal so large a force of cavalry, regular and irregular, that she can better afford to employ considerable masses for special purposes.

However that may be, Russia has maintained for years that large bodies of cavalry, properly armed, formed and trained, are quite capable of acting independently and performing most valuable services to the army at large. But she has done more than this, for she has set herself to work so to organize, arm, and train her cavalry as to give practical proof of this.

Rightly or wrongly, her immediate object in doing this is supposed to be with a view to placing herself in a position to profit by her superiority in cavalry in the event of a rupture with her powerful western neighbour. When this takes place, as it evidently must do sooner or later, Russia is determined to gain the first advantage by taking the initiative and moving

large masses of cavalry across the frontier with the double object of covering her own concentration and interrupting as much as possible that of her neighbour.

In any case, a very material increase has been made in this arm, and no effort is being spared in the preparation in other ways of the cavalry for the services expected of them. Not only have the whole of the regular cavalry of the line been converted into dragoons, after the manner of the corps of Nicholas I, and armed with the Berdan rifle and bayonet, but even the Guard regiments are destined to a like change when ordered to take the field, though the cuirassiers and lancers of the Guard still maintain their old arms and equipment in garrison. Even the Cossack troops have not been allowed to retain their historical lance, which is now only carried by the front rank, and may soon make way altogether for the Berdan.

The increase of regiments by a squadron, effected last year, is of great value, for it not only augments the regular force by 104 squadrons, but it will further admit of training and exercise being carried out with strong regiments on a war footing when the change shall have been completed, which will be in about two years' time.

The thorough instruction of these troops in what, for a large proportion of them, is a new arm, has not been lost sight of; and new musketry regulations provide for their practical training, for which purpose an ample supply of ammunition is provided. But still greater stress has been laid, if possible, upon the training of both horses and men, so as to enable them to adequately fulfil their important *rôle*. To do this adequately must demand great exertions in the way of long and rapid movements and the passage of obstacles. This is provided for by the exercises in forced marches and in swimming rivers, which have been practised lately by bodies of cavalry as a regular exercise.

The marches are made with a view to covering the greatest possible distance in the shortest possible time. They were, when first introduced, only carried out by individual Officers, since which they have been extended to formed bodies of greater or less strength with excellent results. At a cavalry manœuvre last year, for instance, at Achtyrka, a squadron of 162 horses marched from 5 to 6 days at a rate of 38 to 43 miles a day. A still greater feat was achieved by 2 sotnias of Cossacks, which marched from Samostje to Warsaw in 3 days, being at the rate of nearly 70 miles a day, but only about two-thirds of the horses held out.

In the same way swimming was practised in the Warsaw, Odessa, and Moscow districts, the horses being regularly taught with the assistance of inflated bags tied under them. The Suprasl was crossed by the entire 4th Cavalry Division swimming.

The training of the cavalry in pioneer duties is also being carefully attended to, and great importance attributed to it. For the purpose of instruction in these, both Officers and non-commissioned officers are attached to the engineer camp for a course, which lasts from a fortnight to two months.

In the 4th Cavalry Division a regular pioneer squadron has been formed, which is also trained in telegraphy and heliography.

When we consider that Russia can dispose of 21 cavalry divisions, numbering about 3,503 sabres and 12 guns each, with a training such as that which has been briefly described, its value can hardly be overestimated. After providing for the manifold duties connected with covering the operating armies and taking part in the ordinary duties of reconnaissance, large masses could be detached on independent enterprises, such as raiding into the enemy's country with a view to hindering the concentration of his troops, operating against his communications, and seizing in advance of the enemy important strategic points and positions which their constitution will enable them to hold against any but large bodies of infantry.

In the manœuvres all these duties form an important part in the scheme

of operations, and have hitherto given very satisfactory results. General Gourko, of Balkan celebrity, who commands the Warsaw district, issued an order at the conclusion of the manœuvres last year, in which he dwelt especially upon the fact that such duties must form in the future the principal *rôle* of cavalry, and that the employment of masses of cavalry must be carefully avoided on the field of battle, though much may still be expected from small bodies.

In connection with these formations on a large scale of cavalry destined to perform on occasion dismounted duties as infantry, the subject of "mounted infantry" as a distinct branch is briefly discussed by von Löbell. It is admitted by him that this special service may be of much use in connection with operations such as the British expeditions in South Africa, Egypt, or elsewhere, and French operations in Algeria and Tunis, though he does not admit that past experience has established this quite satisfactorily. But for operations on a large scale against a European enemy such formations are not looked on with any favour.

The new French Règlement on the duties of armies in the field contains valuable instructions for the employment of cavalry divisions when covering the advance of an army. Their leaders are to receive their general instructions from the General in chief command; but they are not to be restricted in the choice of their measures and their dispositions. The divisions must at all times be ready for action, and should therefore not be too much extended.

For reconnaissance purposes Officers' patrols should be employed in the first place, followed by reconnoitring squadrons, ordinarily two from each division. Each of these should be divided into two halves, of which one will be extended in patrols of from two to three horses, the other serving as its support. The former extend along the front and round the flanks of the enemy, while the latter are posted between them and the main bodies of the divisions.

The immediate security of the Army is provided for by the cavalry brigades of army corps, at a distance in front of half a day's march. As a rule, one of the two regiments of the brigade performs all the duties of an advanced guard, and furnishes scouts, followed by the remainder as a reserve at a distance of one to two miles. The second regiment marches about the same distance in rear, and about six or seven miles in front of the infantry columns.

On the commencement of an engagement the cavalry clears the front of the infantry. Its sphere is then on the rear or flanks of the enemy, in meeting the opposing cavalry, and to fill up gaps in its own line of battle. Exhausted infantry and artillery on the move form the most appropriate objects for its attack, which must be vigorously and rapidly delivered. In case the enemy is forced to fall back, it must endeavour, in concert with the horse artillery, to convert the retreat into a rout. If the enemy should prove victorious, the cavalry must be prepared to sacrifice itself to cover the retreat.

Field Artillery Tactics.

In 1882 v. Löbell's publication contained some interesting remarks on the subject of the employment of artillery in combination with the decisive attack of infantry. These are concluded in the present volume by a reference to two articles on the same subject, one of which was written by the late celebrated Russian General Todleben, and the other was published in the "Révue Internationale."

In the former the writer states it as his opinion that the infantry attack should be preceded by a concentrated artillery fire at a range of from 2,800 to 1,700 yards. So soon as the enemy's artillery is perceptibly weakened, the

first infantry line should be advanced, and the artillery pushed forward to positions within 1,100 yards of the enemy, and support the infantry by a continued fire. However desirable it may be that the guns should not be masked by the infantry, this must often be unavoidable on account of the ground and the necessary massing of the batteries.

When this is the case the guns may safely fire over the heads of the infantry at ranges of 1,400 yards and upwards; but at shorter ranges guns which are masked must be content to direct their fire on the enemy's reserves. General Todleben does not say what proportion of the guns should actually accompany the infantry to within short range, but he evidently does not favour the employment of large bodies in this manner.

The other article alluded to above adopts the same views, and maintains that the employment of any considerable force of artillery with the infantry can only have the effect of hampering its movements. The main body of the guns should therefore be employed to support the attack from positions at a distance of from 1,300 to 1,600 yards from the enemy, a very small proportion only being detached to accompany the infantry. The guns detailed for this purpose, at the rate of a battery per division, must be pushed boldly forward, and will fulfil their principal object by the moral effect produced by their fire.

This manner of employing the artillery is based upon the principle that the mass should be employed under such conditions as will ensure the maximum effect being produced by their fire. It is evident that this condition will be best fulfilled by the guns occupying good positions at effective range, in which they will be stationary and comparatively undisturbed, than by being mixed up in the turmoil of the immediate attacking line. These views are in accordance with the latest regulations of the German Army on the subject, and though not without their opponents, they may be accepted as sound deductions from more recent experiences on the field of battle.

Fortresses and Railway Communications.

On the Franco-German frontier both the railway system and the water communications have long attained to a development sufficient to fulfil all the war purposes of both those States. This is not the case on the frontiers of Russia with Germany or Austria, where the deficiencies in this respect have been generally acknowledged, and new works demanded. Even where the requirements for the concentration of the field army are fairly fulfilled, the means are inadequate for bringing up at the same time the necessary troops for garrisoning the large fortresses, the immense amount of material generally required to place them in an effective state of defence, and the siege parks, with the enormous quantities of ammunition and material required for them.

The requirement in the matter of ammunition especially is a constantly increasing factor, on account of the number, weight of metal, and rapidity of firing of the guns now employed, and the improved conditions of defence that have to be overcome, while the time-honoured necessity remains of bringing up a sufficiently large amount of it to ensure the operations when once commenced being conducted without a check.

A consideration of the railways on the Russo-German frontier which are of any value to the system of fortresses situated there, shows that two main lines of direct communication formerly existed. The northern one of these ran from St. Petersburg by Wilna to Königsberg and Warsaw respectively. The more southern one was from Moscow by Smolensk, Minsk, and Brescz-Litowsk to Warsaw.

To these have been added two new lines, one from St. Petersburg by Riga and Scharoli to Tilsit, and the other further south from Moscow by Kaluga

and Novo-Belitza to Brescz-Litowsk and Lemberg respectively. Other lines are being actively extended, some of which are in the close vicinity of the German frontier. The further development of the railway system must be dependent upon the construction and situation of the new fortresses, regarding which reports are very contradictory.

The places most generally named as selected for the purpose are Kovno, Goniadz, Grodno, Sieradz, Dubno, Grajevo, and the position of these places in relation to the railway communication gives some probability of the truth of these suppositions. Lately also the fortification of Prenn on the Niemen, some miles south of Kovno, has been planned for the defence of the passage of the river, and in connection with it a new line of rail meeting the Wilna-Vitebsk line.

This will form a part of the general system of defence with Kovno, Grodno, and Grajevo. For the protection of Warsaw 15 forts have been designed, of which 7 are to be on the left bank of the river, on a circumference of 18 miles, and at a distance from the place of 4 miles. Within this first line, and about $1\frac{1}{3}$ miles from it, a second line of 4 forts of similar dimensions to the others are to be constructed.

The protection of the place on the right bank is to be provided for by 4 still larger forts situated 4 miles in advance of the suburb of Praga.

As regards the Austro-Russian frontier, the necessity for completing the railway system so as to facilitate the concentration of an Austrian Army with precision and rapidity has been fully recognized. In West Gallicia, up to the present time, only the line Muncacs-Stryi, for the collection of troops at Lemberg, has been undertaken, and the condition of the railway system for a concentration on the Cracow-Lemberg line continues very unsatisfactory and inadequate. For this purpose three lines exist, viz., Oswiecim-Cracow-Tarnow ; Eperies-Tarnow-Przemyszl, and Michaly-Stryi-Lemberg.

Of these, the first is situated in such close vicinity to the frontier as to be in great danger of interruption by an enemy from the other side of it, which would necessitate the others being so crowded and overworked as to make it very questionable whether even the field army could be concentrated sufficiently early. With a view to rectifying this, and also to the defence of the large fortress of Przemyszl, a new line has been projected. It is to be constructed, roughly speaking, parallel to the more advanced frontier line Ungarisch-Hradisch by the Kara Pass to Silein, following a portion of the Kaschau-Oderberg line to the Jablunka Pass, and then by Seybusch to Cracow on the one side, and by Neu-Sandeck to Przemyszl on the other.

As regards the strengthening of her frontier defence, Austria has latterly chiefly confined her attention to the security of the passes in the Tyrol, which forms in itself such a strong natural protection on the side of Italy, by an extension of the fortifications in the Pusterthal. But if no special activity has been noticeable in the construction of fortresses, Austria has, on the other hand, exerted herself busily to place her siege trains and garrison artillery material on such a footing as to be ready for all eventualities.

Turning to Italy, we find that she has been busy in perfecting her system of frontier defence in many directions. Rome, as a central place of arms, has been fortified, and secured against attack by assault. On the borders both of France and Austria the existing fortifications are being strengthened, and new ones constructed after a scheme proposed by General Pinelli. In the former direction the road over the Mont Cenis is being secured by three forts, which are approaching completion. Enormous sums are being spent in guns and artillery material.

France also, while continuing the completion of her new defences, has undertaken the complete reorganization of her siege-trains, and has formed them of 180 guns of the following calibres :—

8		8·6-in.	guns,	each	with	800 rounds.
40	long	6·1	„	„	„	1,300 „
20	short	6·1	„	„	„	1,100 „
60		4·7	„	„	„	1,150 „
18		3·7	„	„	„	1,150 „
8		10·6	„	mortars	„	600 „
14		8·6	„	„	„	600 „
12	smooth-bore	5·9	„		„	600 „

Each is divisible into 2 half-trains of 4 parts, viz., the main body, the supporting portion, the transport park, and the railway division. The main body consists of three sections, of which the first is composed of 108 vehicles for the conveyance of all that is necessary to the establishment of the park and the construction of the batteries. The second section contains 20 long and 10 short 6·1-in., 30 4·7-in., and 9 3·7-in. guns, 6 smooth-bore 5·9-in., and 7 8·6-in. mortars, 50 wall pieces, defensive implements, and ammunition. The third section carries ammunition alone.

The supporting portion is comprised equally of three sections, the numbering being carried on. Thus the fourth section carries the rest of the ammunition for the main body, the fifth contains the material for establishing workshops for the repair of material, and the sixth has the guns required for special purposes, viz., 4 8·6-in. guns and 4 10·6-in. mortars, with their ammunition and appurtenances. The transport park is composed of 2 columns, each of 44 wagons.

The railway division conveys in 2 half-trains material for the construction of 13 miles of line.

Thirty-four trains are required for the conveyance of a half-siege train by rail, viz., first section, 2; second, 6; third, 5; fourth, 6; fifth, 1; sixth, 5; transport park, 6; railway division, 2; and for the *personnel*, 3.

H. H.

REVIEWS.

Manuel de Droit Maritime International. Par F. PERELS, Conseiller Intime d'Amirauté et Conseiller Référendaire à l'Amirauté Impériale à Berlin. Traduit de l'Allemand et augmenté de quelques documents nouveaux, par L. Arendt, Directeur au Ministère des Affaires Étrangères de Belgique. Paris : Librairie Guillaumin et Cie., 14, Rue Richelieu. Dulau & Co., Soho Square. Size 9″ × 5⅝″ × 1⅜″. Weight 1½ lbs. Pp. 492. Price 7*s.*

Although we have numerous works on International Law in our own language, yet a practical work of this kind, destined especially for the use of Officers of the German Navy, may be read with advantage by students of the subject.

Councillor Perels has compiled this work from his lectures to the students at the Imperial Naval College at Kiel during the years 1873–77.

International law is founded on those eternal principles of justice, implanted by the Creator in his creatures; on this point our author says, "the recognition of the authority in international relations of a superior moral law showed itself as civilization progressed, and became more conspicuous when the Christian spirit replaced, or, at least, largely displaced, the egotism and isolation formerly paramount both in public and private life."

The author devotes 182 pages of his work to international law in time of peace, of which eight are occupied with the consideration of piracy, including the interesting proceedings of the British and German fleets on the south-east coast of Spain, 1873. 169 pages are devoted to "international law in time of war," among which we may note 33 pages to "neutrality," 20 to "contraband of war," and 19 to "blockade."

In the Appendix will be found the text of thirteen important international documents, the most recent being the Convention to regulate the North Sea fisheries, signed at the Hague, May 6, 1882, by Germany, Belgium, Denmark, France, Great Britain, and the Low Countries.

Our author points out that "the word neutrality is not of classical origin, the idea expressed by it not having been known to the ancients."

"Neutrality has a double signification, objective as applied to certain persons and things exempted from the state of war, and subjective as comprehending the relations of States not participating in the war."

Under the head of "contraband of war" we find, "in our opinion coal will fall within or without this category, according to its destination; if it be destined to aid the military operations of a belligerent, it may justly be confiscated."

With this extract we must close our notice of a work likely to be both interesting and useful to naval Officers.—S. L.

Mobilization and Embarkation of an Army Corps. By Lieut.-Colonel ARMAND FURSE. London: Clowes & Sons, 1883. Pp. 251. Size 8¼″ × 5¾″ × 1″. Weight under 1½ lbs. Price 7*s.*

These studies take a far wider range than is implied in the title under which they are presented to the public. They deal with many questions which lie at the root of the system under which our Army is raised and trained; and as the outcome of many years' close and thoughtful study, and of much practical experience in administrative staff work, they form a valuable store-house of information on which those may draw who want to know what are the difficulties to be overcome by the authorities when called on to put an army in the field.

La France par Rapport à l'Allemagne. Étude de Géographie Militaire. Bruxelles: C. Muquardt, 1884. Pp. 375. Size 9″ × 5¾″ × 1″. Weight under 1½ lbs. Price 5s. 6*d.*

This volume contains a detailed and interesting account of the theatre of war in France; of its modifications consequent on the alteration of the frontier in 1871, and of the way in which the strategical problems are affected thereby, both as regards defence as well as offence.

The Nordenfelt Machine-Guns, described in detail and compared with other systems; also their employment for naval and military purposes. Griffin: Portsmouth, 1884. Pp. 206. Size 12½″ × 10½″ × 1¼″. Weight under 5 lbs. Price 30*s.*

This work, illustrated with between fifty and sixty full-page illustrations and diagrams, is a most valuable treatise on what cannot but be regarded as one of the weapons of the future both on sea and land. The illustrations are most elaborate, and are beautifully executed. The book is unique of its kind. The work is one to be studied by Officers of both Services, not only for a knowledge of the technicalities of machine-guns, but also of their tactical adaptation to naval and military warfare.

From Coruña to Sevastopol. The history of "C" Battery, "A" Brigade (late "C" Troop), R.H.A. By Colonel F. A. Whinyates, late R.H.A. London: Allen, 1884. Pp. 308. Size 8″ × 6″ × 1½″. Weight under 1½ lbs. Price 14*s.*

For the majority of readers the interest of this work lies in the portion devoted to the battle of Balaclava—more than one-fourth of the whole book. It commends itself, therefore, to very many who are not gunners, and who might otherwise pass it by, and thus miss some very valuable evidence on that which has always been a matter for keen controversy, the charge of the Light Brigade.

EXTRACT FROM THE BYE-LAWS.

Section II.—Composition.

1. Princes of the Blood Royal; Lords Lieutenant of Counties; Governors of Colonies and Dependencies; Officers of the Army, Navy, Marines, Her Majesty's East Indian Military and Naval Forces, Militia, Yeomanry, Royal Naval Reserve, and Volunteer Corps shall be entitled to become Members, *without ballot*, on payment of the Entrance Fee and Annual Subscription.

N.B. Any Officer coming within the above definition, who may wish to become a Member of the Institution, can do so by copying one of the subjoined Forms, and inclosing it to the Secretary:—

FORM FOR BECOMING AN ANNUAL SUBSCRIBER.

_____ 18

It is my desire to become a Member of the Royal United Service Institution; and I hereby request and authorise my Agents [or Bankers], Messrs. _____, to pay my Entrance Fee (£1) and Annual Subscription (£1) now, and as it becomes due on the 1st of January in each year, to the Secretary of the Institution.

_____ Signature.

_____ Qualification for Membership.

FORM FOR BECOMING A LIFE SUBSCRIBER.

It is my desire to become a Life Member of the Royal United Service Institution; and I hereby authorise my Agents [or Bankers], Messrs._____ to pay my Entrance Fee (£1) and Life Subscription (£9) to the Secretary of the Institution.

_____ Signature.

_____ Qualification for Membership.

2. EX-Governors of Colonies and Dependencies, Retired Officers, Deputy Lieutenants of Counties, Civil Functionaries who are or have been attached to the Naval and Military Departments, the Master, Deputy Master, and Elder Brethren of the Trinity House, and Army and Navy Agents, shall be *eligible* to become Members by *Ballot*.

3. Gentlemen above the age of *fifteen*, whose names are on the list of the Commander-in-Chief for Commissions in the Army, or who are probationary for offices connected with the Naval and Military Professions, shall be *admissible*, by *Ballot*, to become PROVISIONAL MEMBERS from year to year, on payment of the Annual Subscription; and after they obtain their appointments, they may become ordinary Members on payment of the Entrance Fee.

N.B. Members admissible by Ballot must be proposed and seconded by two Members of the Institution, and their names will be submitted to the Council for election. Ballot papers may be obtained at the Institution.

Form of Bequest.

I give and bequeath unto THE ROYAL UNITED SERVICE INSTITUTION, *situated in Whitehall Yard, London, the sum of*

to be applied in and towards carrying on the designs of the said Institution, such Legacy to be paid out of such part of and personal Estate not specifically bequeathed as the law permits to be appropriated by Will to Charitable Purposes.

No. CXXVI CONTAINS:—

OCCASIONAL PAPERS.

THE COUNCIL of the ROYAL UNITED SERVICE INSTITUTION are very desirous of obtaining the assistance of OFFICERS of the NAVAL and MILITARY SERVICES in carrying out the different Courses of Lectures at the Institution.

The Lectures, and the Discussions which follow them (or an Abstract of them), and Descriptions of Inventions, are published in the Journal of the Institution, subject to the discretion of the Council, and illustrated, when necessary, by Diagrams.

N.B.—Officers who will favour the Institution with a Lecture, or a Course of Lectures, are requested to communicate with the Secretary on the subject as early as possible.

By order of the Council,

B. BURGESS, Captain,

Secretary.